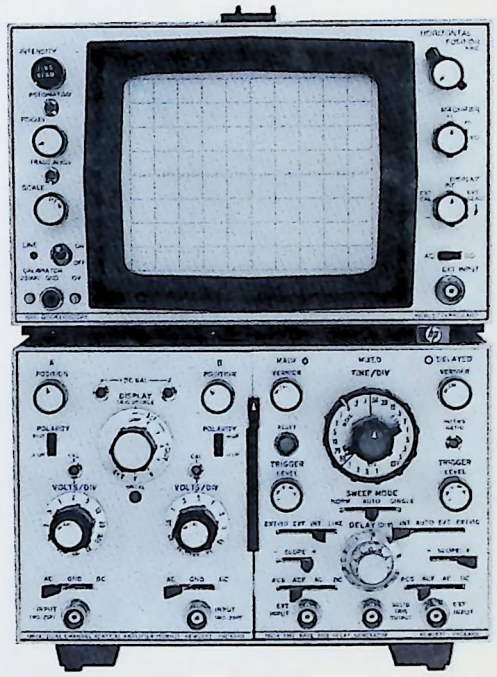
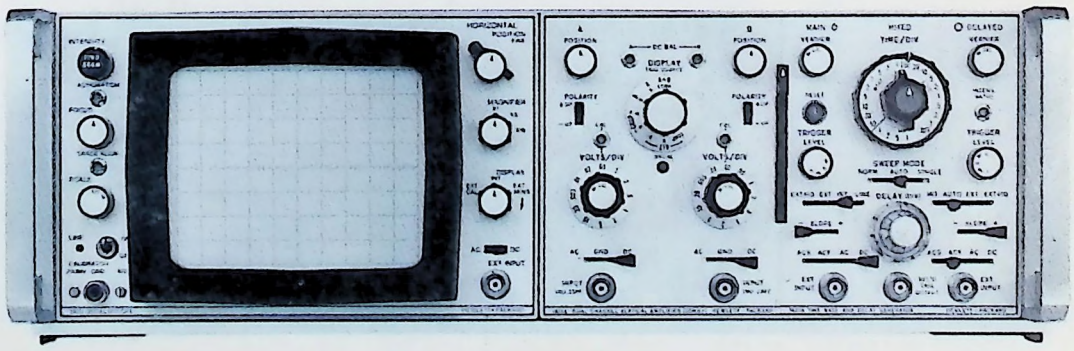
OPERATING AND SERVICE MANUAL

OSCILLOSCOPE

180C/D





HEWLETT hp PACKARD

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

MODEL 180C/D
OSCILLOSCOPE

SERIALS PREFIXED: 1125A

Refer to Section VII for instruments with standard options: **002, 003, 007, 010, 011, 602, 607, 611 and 631.**

Refer to Section VII for instruments with other Serial Prefixes.

HEWLETT-PACKARD COMPANY/COLORADO SPRINGS DIVISION
1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U.S.A.

Manual Part Number: 00180-90915
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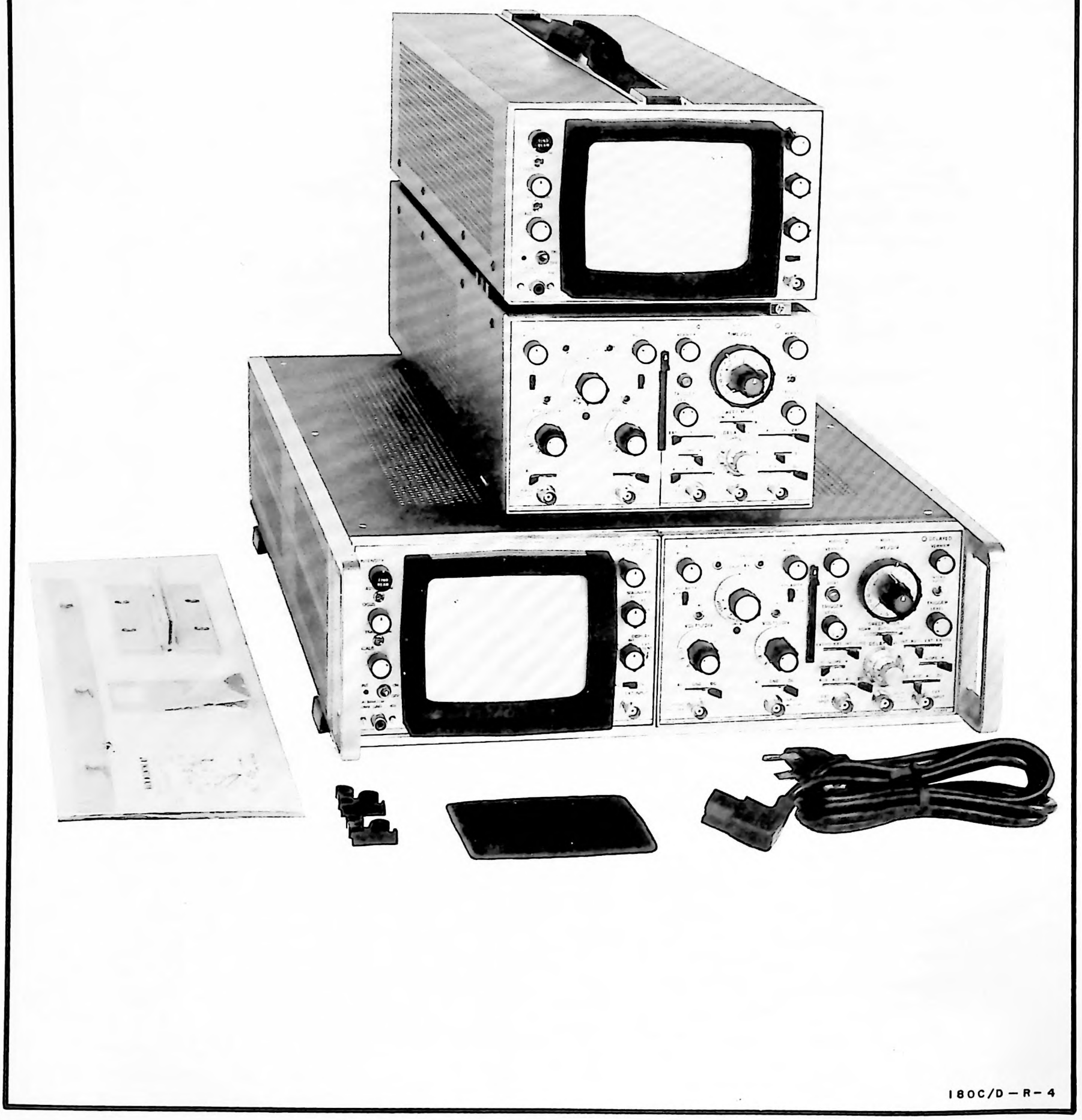


Figure 1-1. Models 180C and 180D Oscilloscopes

SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This manual provides operating and service information for the Hewlett-Packard Models 180C and 180D Oscilloscopes. The manual is divided into eight sections, each covering a specific topic or aspect of the instrument. All schematics are located at the rear of the manual and can be unfolded and used for reference while reading any part of the manual.

1-3. This section contains complete instrument specifications, a description of features, warranty information, data for manual and instrument identification, and information regarding accessories available for use with the instrument. Table 1-2 lists and describes the abbreviations used in this manual.

1-4. INSTRUMENT DESCRIPTION.

1-5. The Model 180C/D (Figure 1-1) is a solid-state, lightweight laboratory and general-purpose oscilloscope with plug-in capabilities. The instrument is designed to display complex high frequency waveforms and to measure alternating and direct-current voltages. Complete instrument specifications are given in Table 1-1.

1-6. The Model 180C is a cabinet type instrument with a built-in tilt stand, convenient carrying handle on top, and feet mounted on both bottom and rear for either bench or upright operation.

1-7. The Model 180D is a rack type instrument with a built-in tilt stand and bottom-mounted feet. It may be bench operated or rack mounted. Figure 1-3 provides the outline dimensions.

1-8. A CRT accelerating potential of 15 kV provides bright visual display and high photographic writing speeds. This simplifies the measurement of low duty cycle signals.

1-9. The Model 180C/D has solid-state circuitry throughout for minimum size and weight with maximum reliability. Power consumption, with plug-ins, is less than 110 watts at normal line voltage. The instrument is convection cooled and designed to operate within specifications at temperatures between 0°C and 55°C with up to 95% relative humidity at 40°C.

1-10. All power supplies, a dual output calibrator, horizontal amplifier, gate amplifier and the CRT are contained in the instrument. Operation at either 115V or 230V ac is selectable by a switch located on the rear panel of the oscilloscope.

1-11. Located on the rear panel are connectors for time base output of main and delayed gate, and main and delayed sweep signals. Connection for input of an external signal for intensity modulation (Z-axis input) is also provided at the rear panel.

1-12. The Model 180C/D is designed to operate with a number of different plug-ins. Presently available plug-ins provide a wide choice of operating capabilities such as wide bandwidth, dual or four channel operation, single or delayed sweeps and sampling or time-domain reflectometer operation.

1-13. To facilitate servicing, the modular power supply may be disconnected and removed from the instrument for access to all components. It may also be operated from the built-in extender cable to simplify and speed up maintenance.

1-14. A calibrator provides a square-wave signal of approximately 1 kHz with a risetime of less than 3 usec. The calibrator output is available at the front panel at amplitudes of 250 mV and 10V p-p with an accuracy of ±1%. The signal may be used to check horizontal and vertical deflection factors and to compensate divider probes.

1-15. The oscilloscope horizontal amplifier accepts sweep signals from the time base plug-in or an external source. The external input bandwidth is dc to 5 MHz dc-coupled, and 5 Hz to 5 MHz ac-coupled.

1-16. Three horizontal deflection factor ranges are front panel selectable: 1 V/div (X1) ±5%, 0.2 V/div (X5) ±5%, and 0.1 V/div (X10) ±5%. In addition, a vernier control provides continuous adjustment between ranges for external inputs. The maximum external input level is 300 Vdc, ac-coupled, with a dynamic range of ±20V.

1-17. A beam finder pushbutton control assists the operator in rapidly bringing a displaced beam on screen. Its use increases intensity and reduces vertical and horizontal amplifier gain to quickly locate trace position.

1-18. CATHODE-RAY TUBE.

1-19. The Model 180C/D uses a post-accelerator aluminized CRT with an eight by ten division display area. Each division equals 1 cm, and 0.2-div subdivisions are provided on the major axes. The graticule is internal to the CRT which eliminates display parallax. A safety faceplate is bonded to the front of the CRT for implosion protection.

1-20. The standard CRT supplied has P31 phosphor. Other phosphors with or without internal graticule are available.

Refer to Section VII of this manual for information on available phosphors or contact the nearest HP Sales/Service Office regarding special CRT requirements.

1-21. WARRANTY.

1-22. This instrument is certified and warranted as stated on the inside front cover of this manual. The CRT is covered by a separate warranty. The CRT warranty and warranty claim form are located at the rear of this manual. Should the CRT fail within the time specified in the warranty, fill out the failure report form and return it with the CRT.

1-23. In all correspondence with a Hewlett-Packard Sales/Service Office concerning an instrument, reference the complete serial number and model of this instrument.

CAUTION

The warranty may be void for instruments having a mutilated serial number tag.

1-24. INSTRUMENT IDENTIFICATION.

1-25. Hewlett-Packard uses a serial number for instrument identification (Figure 1-2). The first numerical group is the serial prefix number. It identifies a series of instruments. The last numerical group identifies a particular instrument in the series. The serial number appears on a plate located on the rear panel.

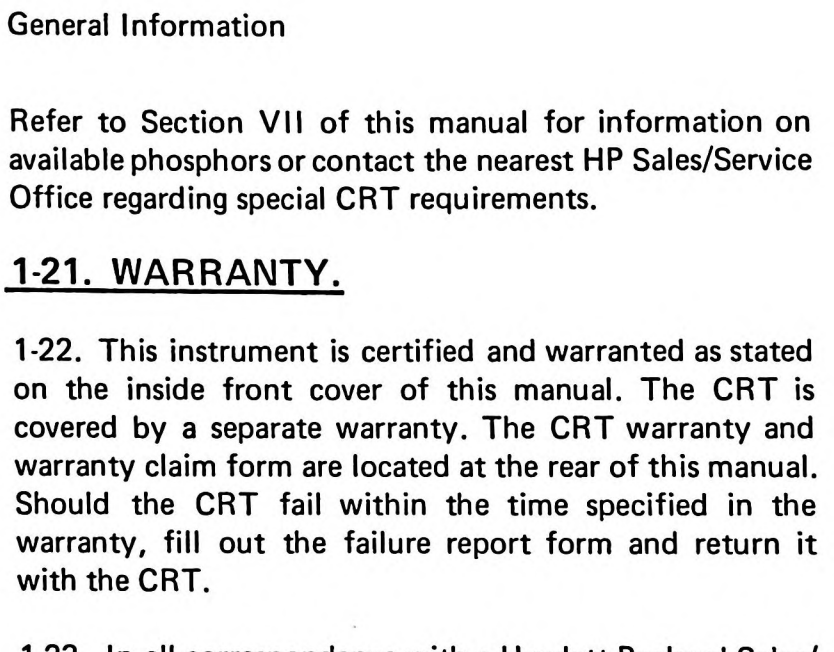


Figure 1-2. Instrument Identification

1-26. MANUAL IDENTIFICATION AND CHANGES.

1-27. The information in this manual applies directly to instruments (as manufactured) with a serial prefix as indicated on the title page. If the serial prefix of your instrument is different from that on the title page, a MANUAL CHANGES insert sheet, or Section VII of the manual, will describe the changes necessary to adapt this manual to provide the correct information.

1-28. Technical corrections (if any) to this manual due to known errors in print are called Errata and are shown on the manual changes sheet. Also shown are changes in parts which are applicable to all instruments should replacement become necessary. These are indicated as preferred replacement parts.

1-29. For information on manual coverage of any HP instrument, contact the nearest HP Sales/Service Office (addresses are listed at the rear of this manual).

1-30. ACCESSORIES FURNISHED.

1-31. The Model 180C/D is equipped with a screen mesh contrast filter. The filter snaps into place under the light shield to provide greater contrast and improved viewing under ambient light conditions. It may be removed if preferred.

1-32. A detachable power cord is supplied with each instrument. The three-conductor power cord and instrument receptacle conform to International Electrotechnical Commission (IEC) safety standards.

1-33. The Model 180D is supplied with all parts and hardware required for rack mounting. Refer to Section II of this manual for installation information.

1-34. Two probe hangars are furnished with each oscilloscope. Model 180C hangers are factory installed while probe hangers for the Model 180D are furnished for user installation.

1-35. AVAILABLE ACCESSORIES.

1-36. MOBILE TEST STANDS.

1-37. Hewlett-Packard Testmobiles provide ease and convenience for moving 180 system oscilloscopes to different test locations. Model 1119A and 1119C Testmobiles can also be equipped to provide extra storage space for plug-ins and accessories, which increases test bench working area. Model 1118A Testmobile is designed for 180 system cabinet models and provides continuous height adjustment from 33 to 43 inches, continuous tilt from −45° to +45°, and 360° rotation with large 3-inch locking wheels for mobility. This folding tripod, lightweight, testmobile is easy to transport to field test sites and store.

1-38. Models 1119A and 1119B Testmobiles equipped with Model 10479B Tilt Tray or two mounting plates (HP Part No. 01119-69501) provide mobility for modular rack mount 180-system oscilloscopes. The tilt tray may be rotated in 10° increments from −20° to +30° for convenient viewing. When equipped with the optional mounting plates, the rack model may be rotated on 10° increments from −30° to +40°. For added storage space on the Test-

Table 1-1. Model 180C/D Specifications

CATHODE-RAY TUBE AND CONTROLS

TYPE: post accelerator, approx 15 kV accelerating potential; aluminized P31 phosphor; safety glass faceplate.

GRATICULE: 8 x 10 div internal graticule, 0.2 div subdivisions on major axes. (1 div = 1 cm.) Front panel recessed screwdriver adjustment aligns trace with graticule. Scale control illuminates CRT phosphor when viewing with hood or taking photographs.

BEAM FINDER: returns trace to CRT screen regardless of setting of horizontal, vertical, or intensity controls.

INTENSITY MODULATION (External Input)

Input: approx +2V, ≥50 ns pulse width (≤10 MHz sine wave) will blank trace of normal intensity.
Input R: approx 5k ohms.
Maximum Input: ±20V (dc + pk ac).

PHOTOGRAPHIC WRITING SPEED: 1500 cm/usec. Measured using 10,000 ASA film without film fogging and HP Model 195A camera (1.3 lens, 1:0.5 object-to-image ratio). Writing speed may be increased substantially by using film fogging techniques, P11 phosphor and faster camera lenses.

CALIBRATOR

TYPE: approx 1 kHz square wave, <3 usec risetime.

VOLTAGE: two outputs, 250 mV p-p and 10V p-p into ≥1 megohm; accuracy, ±1%.

HORIZONTAL AMPLIFIER

EXTERNAL INPUT

Bandwidth: dc to 5 MHz dc-coupled; 5Hz to 5 MHz ac-coupled.
Deflection Factor: 1 V/div, x1; 0.2 V/div, x5; 0.1 V/div, x10; accuracy ±5%. Vernier provides continuous adjustment between ranges.
Dynamic Range: ±20V.
Maximum Input: 600 Vdc (ac-coupled input).
Input RC: approx 1 megohm shunted by approx 30 pF.

INTERNAL SWEEP

Magnifier: x5, x10, accuracy ±5% (with 3% accuracy time base).

OUTPUTS

Four rear panel, emitter follower outputs provide main and delayed gates, main and delayed sweeps, or vertical and horizontal outputs when used with TDR/Sampling plug-ins. Maximum current available, ±3 mA. Outputs will drive impedances of ≥1000 ohms without distortion.

ENVIRONMENT

(Mainframe operates within specifications over the following ranges.)

TEMPERATURE: 0 to 55°C.

HUMIDITY: to 95% relative humidity to 40°C.

ALTITUDE: to 15,000 ft.

VIBRATION: vibrated in three planes for 15 min each with 0.010 in. excursion, 10 to 55 Hz.

GENERAL

POWER: 115 or 230V, ±10%; 48 to 440 Hz; normally <110W with plug-ins at normal line. Maximum mainframe power, 200 VA.

DIMENSIONS:

Cabinet Model 180C: 7-7/8 in. wide, 11-3/8 in. high, 21-1/4 in. deep behind panel (200 x 289 x 540 mm).
Rack Model 180D: see outline drawing.

ACCESSORIES FURNISHED: 7-1/2 ft power cord; Model 10179A mesh contrast filter; rack-mounting hardware and 2 probe holders (HP P/N 5040-0464) are also supplied with 180D Rack Model.

OPTIONS

Refer to Section VII for listing of options.

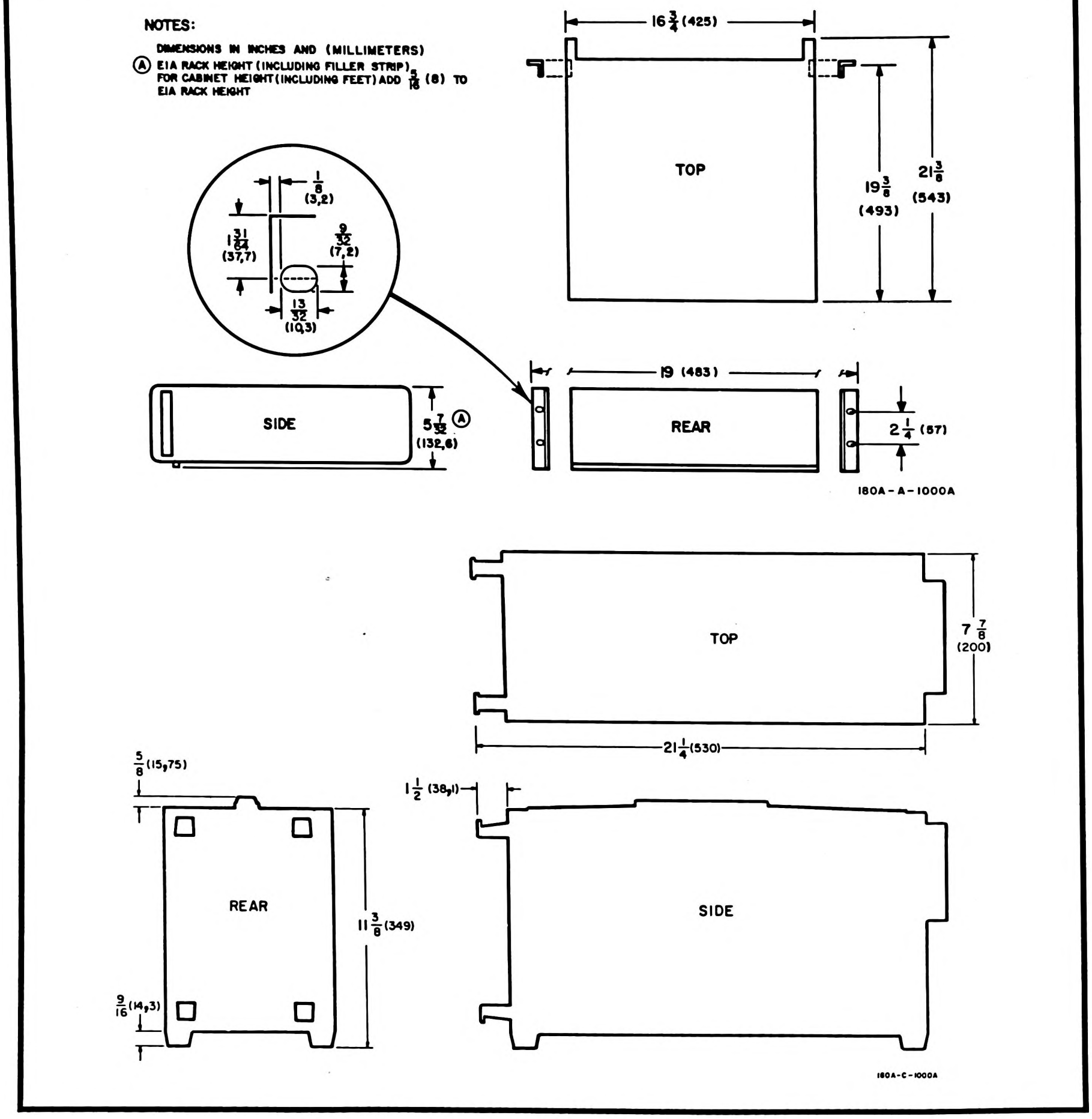


Figure 1-3. Model 180C and 180D Dimensions

mobile, a large storage cabinet (Model 10480A) is available. This cabinet has a drawer for accessories, adapters, and other small items and a shelf for storing plug-ins or other small instruments. Model 10480A Storage Cabinet is available separately or can be ordered factory installed in Model 1119B Testmobile. Either the Tilt Tray or Mounting Plates are required to mount a rack instrument on Model 1119A or B Testmobile.

1-39. Models 1119C and 1119D Testmobiles provide an easy means of moving 180-system cabinet model oscilloscopes from one test location to another and provide storage space for extra plug-ins. The oscilloscopes attach to a support bracket which allows ±30° movement in 10° increments. Model 1119C has a lateral brace that has storage space for small accessories and Model 1119D has a large storage cabinet (Model 10480B)

factory installed in place of the lateral brace. Model 10480B contains a drawer for adapters, etc. and storage space for additional plug-ins.

1-40. COVERS.

1-41. A front-panel cover of fiberglass material, HP Model 10166A, can be used to provide front-panel protection for the cabinet Model 180C, and a metal cover for the rack Model 180D is available as HP Part No. 5060-0437.

1-42. Model 10167A is a flexible cover made of vinyl material. It fits over the cabinet Model 180C and provides instrument protection during transportation or storage. The top of the cover is slotted for access to the carrying handle and has a pocket on the side for an operating manual and/or probes and accessories.

1-43. CAMERAS.

1-44. The HP Models 195A, 197A, and 198A Cameras provide accurate records of oscilloscope displays. Model 195A is a high-speed camera with electronic shutter, 80 mm, f/1.3 lens, and 1:0.5 object-to-image ratio for photographing fast single-shot traces. A Polaroid® roll film holder is supplied for use with 10,000 ASA film. While specifically designed for use with a high writing speed oscilloscope, its many features, such as a film back that is moveable through 11 detented positions for multiple exposures, and interchangeable film backs, provides general purpose use.

1-45. Model 197A is a general purpose camera with an electronic shutter and an ultra-violet light which illuminates internal graticules, providing accurate recordings of oscilloscope displays. The film back can be moved through 11 detented positions for multiple exposures and the continuous reduction ratio allows the entire film area to be used. Model 197A is supplied with a Polaroid® pack film back for Type 107 film. Interchangeable backs on Models 195A and 197A allow selection of a Polaroid® Roll Film back (Model 10365A), Polaroid® Flat Pack back (Model 10353A), or a Graflok® 4 x 5-inch back (Model 10352A).

1-46. Model 198A is an economical, easy-to-use camera for general purpose oscilloscope photography which uses standard Polaroid® flat-pack self-processing film. A mirror focus system interlocked with the battery powered graticule illumination system simplifies focusing and eliminates the need for focus plates. Most oscilloscope photographic applications can be solved with this economical camera.

1-47. SERVICE EQUIPMENT.

1-48. For ease of calibration and maintenance, the HP Model 10407A Plug-in Extender can be obtained. It provides for removal of the vertical and time base plug-ins from the oscilloscope mainframe and exposes components and adjustments of the plug-ins for servicing.

1-49. A Horizontal Gain Calibrator, HP Model 10411A, is available. It is used to rapidly and accurately calibrate the Model 180C/D horizontal deflection factor without the use of additional test equipment.

1-50. BLANK PLUG-INS.

1-51. Blank plug-ins are available for use with the Model 180C/D. They provide the necessary chassis and interconnection components for installation of user-designed horizontal and/or vertical deflection circuitry. Each fits into the oscilloscope plug-in compartment, and provides for obtaining operating power from the oscilloscope power supplies. The following units are available at the present time: HP Model 10408A Vertical Blank Plug-in, HP Model 10409A Horizontal Blank Plug-ins and HP Model 10410A Dual Blank Plug-in. The operating power which may be obtained from the oscilloscope for user-designed circuits is listed in Section IV.

1-52. OTHER ACCESSORIES.

1-53. Additional RFI shielding for the CRT display can be obtained by using the Model 10178A Metal Mesh Contrast Filter in place of the filter supplied.

1-54. Cameras, probes, viewing hoods, terminations and other accessory items are available for specialized requirements. Information on these and the above described accessories may be obtained from HP Sales/Service Offices listed in the rear of this manual.

Table 1-2. Reference Designators and Abbreviations

REFERENCE DESIGNATORS

A	= assembly	E	= misc. electrical part	P	= plug	U	= integrated circuit (unrepairable)
AT	= attenuator, resistive termination	F	= fuse	PS	= power supply	V	= vacuum tube, neon bulb, photocell, etc.
B	= motor, fan	FL	= filter	Q	= transistor	VR	= voltage regulator (diode)
BT	= battery	H	= hardware	R	= resistor	W	= cable
C	= capacitor	J	= Jack	RT	= thermistor	X	= socket
CP	= coupling	K	= relay	S	= switch	Y	= crystal
CR	= diode	L	= inductor	T	= transformer	Z	= network
DL	= delay line	LS	= speaker	TB	= terminal board		
DS	= device signaling (lamp)	M	= meter	TP	= test point		
		MP	= mechanical part				

ABBREVIATIONS

A	= ampere(s)	FET	= field-effect transistor(s)	n	= nano (10^{-9})	rfi	= radio frequency interference
ampl	= amplifier(s)			nc	= normally closed	rms	= root mean square
assy	= assembly			no.	= normally open	rwv	= reverse working voltage
ampltd	= amplitude	G	= giga (10^{9})	npn	= negative-positive-negative		
bd	= board(s)	gnd	= ground(ed)	ns	= nanosecond	SCR	= silicon controlled rectifier
bp	= bandpass	H	= henry(ies)	p	= pico (10^{-12})	sec	= second(s)
c	= centi (10^{-2})	hr	= hour(s)	pc	= printed (etched) circuit(s)	std	= standard
C	= carbon	HP	= Hewlett-Packard	pk	= peak	trmr	= trimmer
ccw	= counterclockwise	Hz	= hertz	pnp	= positive-negative-positive	u	= micro (10^{-6})
coax.	= coaxial	if.	= intermediate freq.	p/o	= part of	usec	= microsecond
coef	= coefficient	intl	= internal	p-p	= peak-to-peak	V	= volts
com	= common	k	= kilo (10^{3})	prgm	= program	var	= variable
CRT	= cathode-ray tube	lb	= pound(s)	prv	= peak inverse voltage(s)	w/	= with
cw	= clockwise	lpf	= low-pass filter(s)	ps	= picosecond	w/o	= without
d	= deci (10^{-1})	m	= milli (10^{-3})	pwv	= peak working voltage	wiv	= working inverse voltage
dB	= decibel	M	= mega (10^{6})	rf	= radio frequency		
ext	= external	ms	= millisecond				
F	= farad(s)						

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SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section of the manual contains inspection and installation procedures for the Model 180C/D Oscilloscope. In addition, packing and claims procedures are discussed in the event damage occurs during shipment.

2-3. INITIAL INSPECTION.

2-4. The instrument was carefully inspected, mechanically and electrically, prior to shipment. On receipt, inspect it for any mechanical damage which may have occurred during shipment and test the electrical performance.

2-5. Check for physical damage such as bent or broken parts and dents or scratches. If damage is found, refer to the recommended claims procedure. Retain the packaging material for future use.

2-6. Check the electrical performance of the instrument as soon as possible after receipt. The performance check is contained in Section V of this manual. This check will verify that the instrument is operating to the specifications listed in Table 1-1.

2-7. The initial performance and accuracy of this instrument are certified as stated in the warranty on the inside front cover of this manual. If the instrument does not operate as specified, refer to the recommended claims procedure.

2-8. CLAIMS.

2-9. If physical damage is found or if the instrument is not within specifications when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office immediately. The Sales/Service Office will arrange for repair or replacement of the instrument without waiting for a claim to be settled with the carrier.

2-10. The warranty statement for this Hewlett-Packard instrument is on the inside front cover of this manual. Contact the nearest HP Sales/Service Office for information and assistance with warranty claims.

2-11. REPACKING FOR SHIPMENT.

2-12. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag to it showing owner's name, address, instrument model number and serial number, and a description of the service required.

2-13. Use the original shipping carton and packaging materials for reshipment. If they are not available, repackage the instrument with the following materials:

a. A double-walled carton (refer to Table 2-1 for test strength required).

b. Heavy paper or sheets of cardboard to protect all instrument surfaces (use nonabrasive material such as polyurethane or cushioned paper such as Kimpak around all projecting parts).

c. At least 4 inches of tightly-packed, industry-approved, shock-absorbing material such as extra-firm polyurethane foam.

d. Heavy-duty shipping tape to secure outside of carton.

Table 2-1. Shipping Carton Test Strength

Gross Weight (lb)	Carton Test Strength (lb)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

2-14. PREPARATION FOR USE.

2-15. POWER REQUIREMENTS.

2-16. The standard Model 180C/D requires a 115V or 230V ±10%, single-phase, 48 to 440 Hz power source capable of supplying 200 VA maximum or approximately 110 watts at normal line voltage with plug-ins installed.

2-17. 115V OPERATION. This instrument, as shipped, is ready for operation on 115V ac. Before applying power, check the rear-panel slide switch, labeled SELECTOR, for proper position. It should be set so the legend 115 is visible. Check the fuse to determine that it is the proper value to provide protection for 115V operation of the instrument.

2-18. 230V OPERATION. If the instrument is to be operated from a 230V ac power source, set the rear-panel SELECTOR slide switch to 230. Replace the fuse with the proper value for 230V operation.

2-19. THREE-CONDUCTOR POWER CABLE.

2-20. The National Electrical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded to protect operating personnel. The

Model 180C/D is provided with a detachable three-conductor power cord which, when plugged into an appropriate outlet, grounds the instrument. The oscilloscope mainframe power jack and the mating plug of the power cord conform to International Electrotechnical Commission (IEC) safety stnadards.

2-21. When operating the Model 180C/D from a two-contact power outlet, use a three-conductor to two-conductor adapter. Preserve the safety feature by grounding the adapter flexible (third) lead. A suitable three-pin to two-pin adapter is available from Hewlett-Packard. Order HP Part No. 1251-0048.

2-22. INSTRUMENT MOUNTING.

2-23. The Model 180C is intended for bench use. It has a built-in tilt stand and feet mounted on both bottom and rear for bench or upright operation.

2-24. The Model 180D is intended for either bench or rack use. It has a built-in tilt stand and feet mounted on the bottom for bench use. It may be rack mounted as described below.

2-25. BENCH USE. To use the tilt stand, lift the front of the instrument or place it vertically on the rear feet. The tilt stand is folded and locked into place against the cabinet bottom cover. Hold the instrument steady and squeeze the two tilt stand legs together to release them from the lock. Pull the stand toward the front of the instrument. When fully forward, release the legs and they will lock into position. The tilt stand will support the instrument with the front elevated.

2-26. RACK MOUNTING. A kit for converting the Model 180D to a rack mount configuration is supplied with each instrument. Instructions for making the conversion are given below. See Figure 2-1 for parts identification.

a. Detach tilt stand by pressing it away from front feet. Remove all plastic feet by depressing metal button and sliding feet free.

b. Remove aluminum trim strip from each side of instrument with thin blade tool.

c. Attach rack mounting flange in space where trim strip was removed (use screws provided with kit). Large notch of flange should be positioned at bottom of instrument.

2-27. INSTRUMENT COOLING.

2-28. This instrument does not require forced-air-cooling when operated at room temperature or between 0 and +55 degrees C. Normal air circulation will maintain a reasonable operating temperature within the instrument.

2-29. Perforations in the covers provide for the required air flow. Do not obstruct them. Provide several inches of clearance around the top, rear and sides. Adequate air flow from the bottom of the instrument is provided by the mounting feet.

2-30. CONTRAST FILTER.

2-31. The contrast filter is designed to be easily removed from the CRT bezel. Use of the contrast filter provides

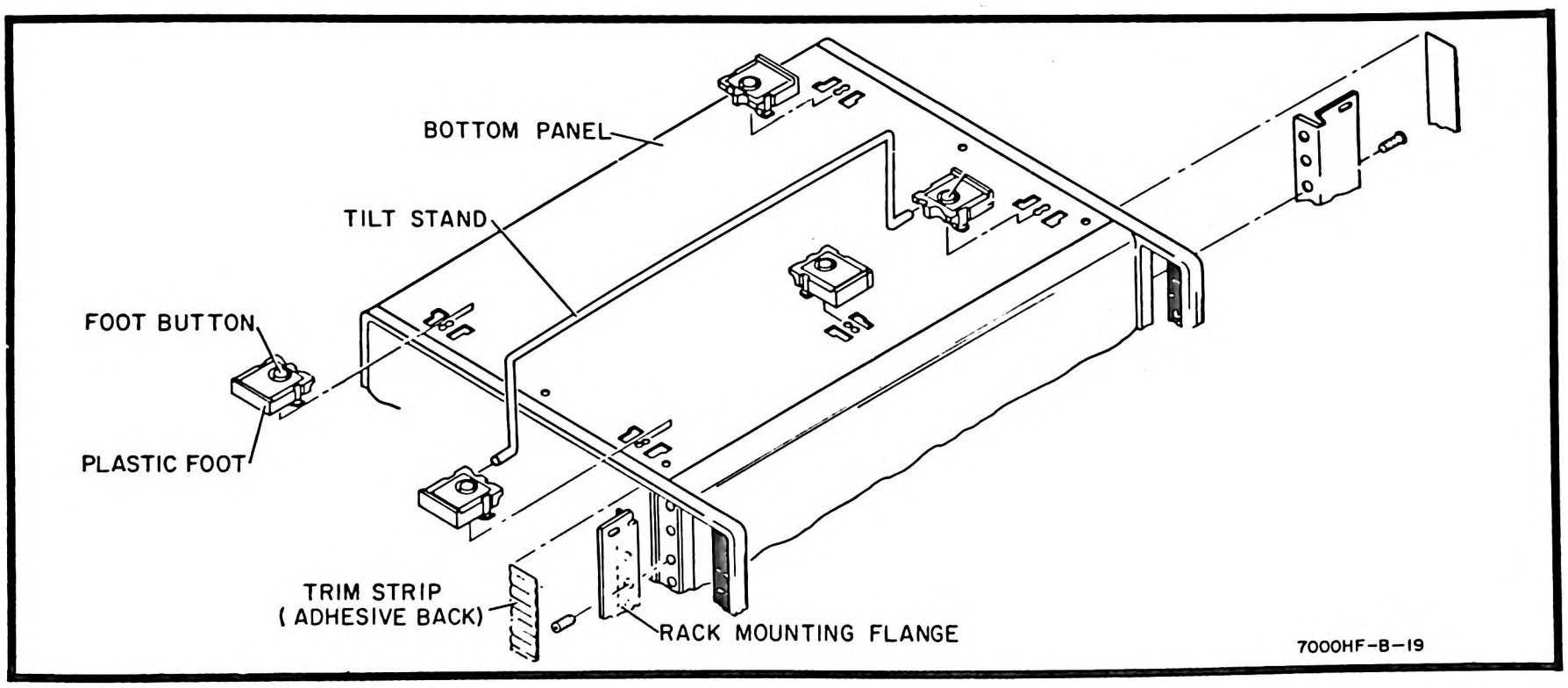


Figure 2-1. Rack Mount Procedure

comfortable viewing when the instrument is operated in normal and high ambient light.

2-32. The contrast filter is located behind the light shield. When a camera is attached for use, removal of the filter may be desirable.

2-33. To remove the plastic light shield, squeeze it at midpoint at top and on bottom. Apply pressure until upper and lower ears clear the slots in the bezel. Pull forward and remove.

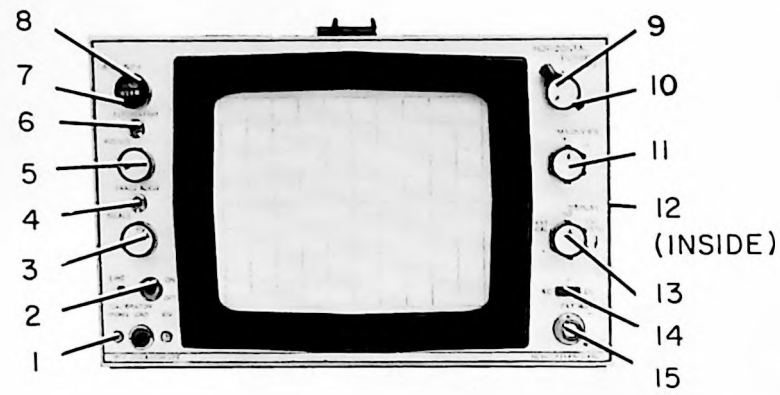
2-34. Remove the contrast filter, which is held in the bezel by a loose pressure fit.

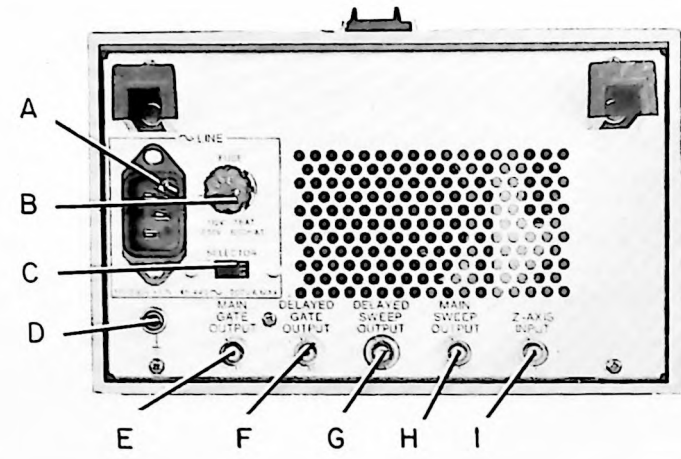
2-35. INSTRUMENT COMPATIBILITY.

2-36. The Model 180C/D Oscilloscope is designed to operate with a wide variety of time base and vertical plug-ins. Table 3-1 lists the plug-ins currently available.

Note

Plug-ins specifically designed for use with the 500-MHz Model 183A/B/C/D Oscilloscope will not fit into or operate in the Model 180C/D. A mechanical interlock is provided on these plug-ins which prevents their full insertion into the Model 180C/D. Additionally, the Model 180C/D does not supply the required operating power.





1. CALIBRATOR. Provides a 1-kHz square wave at two amplitudes; 250 mV and 10V p-p.

2. LINE. Toggle switch with indicator light for turning oscilloscope on and off.

3. SCALE. Controls overall brightness of CRT face and graticule contrast.

4. TRACE ALIGN. Rotates trace around longitudinal axis of CRT.

5. FOCUS. Adjusts writing beam for sharpest trace.

6. ASTIGMATISM. Adjusts roundness of writing spot.

7. INTENSITY. Controls brightness of display.

8. FIND BEAM. Intensifies trace and always returns display to on-screen.

9. POSITION. Coarse adjustment of display's horizontal position.

10. FINE. Fine adjustment of display's horizontal position.

11. MAGNIFIER. Determines gain of horizontal amplifier.

12. PHASE/BANDWIDTH. Selects between normal full bandwidth operation (BANDWIDTH) and X-Y operation (PHASE).

13. DISPLAY. Selects source of horizontal input signal.

14. AC/DC. Selects ac or dc coupling for the external horizontal input signal.

15. EXT INPUT. BNC connector for coupling an external horizontal input signal to horizontal amplifier.

REAR PANEL

A. Power Connector. 3-wire ac power line input.

B. FUSE. 115V or 230V operation ac line fuse.

C. SELECTOR. Provides for external selection of line operating voltage.

D. Ground Connector. Provides a chassis ground connection point.

E. MAIN GATE OUTPUT. BNC connector for main gate signal to external equipment.

F. DELAYED GATE OUTPUT. BNC connector for output of delayed gate signal to external equipment.

G. DELAYED SWEEP OUTPUT. BNC connector for output of delayed sweep signal to external equipment.

H. MAIN SWEEP OUTPUT. BNC connector for output of main sweep signal to external equipment.

I. Z-AXIS INPUT. BNC connector for input of CRT intensification or blanking signal.

180C/D-R-2

Figure 3-1. Operating Controls and Connectors

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. This section of the manual presents information on the operation, function and capabilities of the instrument controls. Information regarding control turn-on procedures and front panel adjustments is explained to assist the operator in properly setting up and using the Model 180C/D.

3-3. GENERAL.

3-4. The Model 180C/D is designed to operate with plug-in time bases and vertical amplifiers, or plug-in sampling and time-domain reflectometers. These plug-ins are accommodated in the lower or right-hand portion of the instrument. The required operating power is obtained from the oscilloscope mainframe. Time base and vertical amplifier units must be locked together before being installed in the mainframe.

3-5. The vertical amplifier is always installed in the left-hand side and the time base on the right-hand side of the plug-in compartment. Refer to the plug-in operating and service manuals for mating and installation instructions. Sampling and TDR plug-ins use the entire active plug-in compartment.

3-6. FRONT PANEL CONTROLS AND CONNECTORS.

3-7. All operating controls and front panel adjustments are identified and described in Figure 3-1. The information presented gives the operator a quick reference regarding the operating function of each. Additional information regarding some of these is explained below in greater detail.

3-8. CALIBRATOR.

3-9. The calibrator has two outputs, 10V and 250 mV peak-to-peak, negative-going from ground, with an amplitude accuracy of ±1%. The output is a square wave at a frequency of approximately 1 kHz. Risetime of the signal is less than 3 microseconds. These outputs are useful for checking vertical and horizontal sensitivity calibration, and divider probe calibration. A 3-way binding post provides a convenient ground connection point and may be used with banana plug, wire or spade-lug connection.

3-10. SCALE.

3-11. This control adjusts the overall brightness of the CRT face. It should be adjusted for good contrast between the background and the graticule. The SCALE control is useful when using a hood to view the display or when photographing waveforms. Rotate the SCALE control counterclockwise to OFF when graticule illumination is not needed.

3-12. TRACE ALIGN.

3-13. A screwdriver adjustment is used to compensate for external magnetic fields that may affect alignment of the horizontal trace with the graticule. Use it to position the trace parallel to the graticule horizontal lines. The alignment should be checked when the instrument is moved to a new location and adjustment made whenever necessary.

3-14. FOCUS AND ASTIGMATISM.

3-15. These controls are used to obtain a display of uniform focus. Adjust both controls for the sharpest display possible.

3-16. FIND BEAM.

3-17. Occasionally the CRT beam may be driven offscreen by large dc input levels or improper control settings. Pressing the pushbutton increases intensity and reduces horizontal and vertical amplifier gains enough to always return a displaced beam to the viewing area. This enables the operator to determine the action necessary to center the display. All operating controls function while the FIND BEAM control is depressed. Obtaining a centered display may require adjustment of the deflection factor, horizontal and vertical position, coupling, trigger level or intensity. If the controls are properly set, the display will remain visible when FIND BEAM is released.

Note

Option 011 and 611 instruments do not increase intensity when FIND BEAM is pressed. Use the INTENSITY control to set intensity to viewing level.

3-18. LINE POWER SWITCH.

3-19. This toggle switch applies or removes ac line input power to the instrument. When ON, an indicator lamp, located next to the switch, is lit. Power for the lamp is obtained from the low voltage power supply. Both sides of the ac power line input are interrupted when switched to OFF.

3-20. HORIZONTAL DISPLAY.

3-21. Either of two modes of operation can be selected with this control. It selects the origin of the input signal applied to the horizontal amplifier. When INT is selected, the input signal to the horizontal amplifier is obtained from the time base plug-in. With the DISPLAY control positioned to EXT CAL, the sweep signal input from the plug-in is disconnected, and the EXT INPUT signal is used to develop the display sweep.

Note

Time base plug-ins are normally adjusted to provide a sweep length greater than 10 divisions. Refer to the applicable time base operating and service manual for adjustment information.

3-22. HORIZONTAL EXTERNAL COUPLING.

3-23. An external input signal may be connected to the horizontal amplifier via the EXT INPUT BNC connector when DISPLAY is set to EXT. The coupling switch is used to select ac coupling (capacitive coupling) or dc coupling to the amplifier.

3-24. HORIZONTAL MAGNIFIER.

3-25. This switch controls the gain of the horizontal amplifier in three steps. When INT DISPLAY is selected and MAGNIFIER is set to X1, the displayed sweep speed is as selected at the time base plug-in. When switched to X5, the gain is increased five times, and when set to X10, the gain is increased 10 times. Time base selected sweep speeds are thus increased X5 or X10 the indicated sweep speed.

3-26. When an EXT INPUT signal is selected to drive the horizontal amplifier, 1 volt of signal will result in 1 division of deflection in X1, 5 divisions of deflection in X5 and 10 divisions of deflection in X10.

3-27. EXTERNAL SENS.

3-28. The deflection factor of an external input signal can be continuously varied to decrease deflection by a factor of approximately 10 by using this control. When the vernier is in the maximum clockwise position (CAL detent), the horizontal amplifier is calibrated to provide 1.0 V/div deflection in the X1 magnifier range, 0.25 V/div in the X5 range, and 0.1 V/div in the X10 range. Counterclockwise rotation from the CAL POSITION decreases the uncalibrated gain.

3-29. REAR PANEL CONTROLS AND CONNECTORS.

3-30. Rear panel controls and connectors are identified and described in Figure 3-1. Additional information regarding these is explained below in greater detail.

3-31. OUTPUTS.

3-32. Four BNC connectors on the rear panel of the Model 180C/D are provided to supply signals from the time base or sampling plug-in to external equipment. The low impedance outputs are isolated from the high impedance input signals. The period of the signal output is directly related to the main and delayed sweep speed selected for the time base plug-in or the vertical and horizontal outputs when used with sampling plug-ins. Refer to the operating and service manual for the plug-in to determine signal identification.

3-33. The time base output of the MAIN SWEEP OUTPUT and the DELAYED SWEEP OUTPUT is a positive-going ramp of about 5 volts amplitude. The time base output of the MAIN GATE OUTPUT and the DELAYED GATE OUTPUT is a negative-going pulse of about 2.5 volts amplitude. These outputs can supply 3 mA and will drive impedances as low as 1000 ohms without distortion.

3-34. Z-AXIS INPUT.

3-35. An external signal can be utilized to control the CRT intensity. The intensity modulation signal is applied directly to the CRT intensity gate amplifier. A pulse of approximately +2V amplitude and a width of at least 50 nanoseconds or a +2V continuous wave (cw) input of 10 MHz or lower will blank a trace of normal intensity. Input of a negative signal can be used for display intensification.

3-36. AC LINE INPUT.

3-37. A three-conductor ac power cord is provided for ac input. A power line ground is obtained through the power cord. Also located on the rear panel is the SELECTOR line slide switch which allows operation from either 115V or 230V ac line power. Fuses are provided for both 115V and 230V operation, and must be changed to the proper value when line input is switched.

3-38. PHASE/BANDWIDTH SWITCH.

3-39. A PHASE/BANDWIDTH switch is located within the instrument on the horizontal amplifier assembly. The instrument top cover must be removed for access to this switch. Positioning the PHASE/BANDWIDTH switch to PHASE causes an external horizontal input signal to be delayed the same amount of time as the vertical input signal. This delay allows the Model 180C/D to be used for phase measurement. The switch should always be in the BANDWIDTH position unless the instrument is being used for phase measurement.

3-40. PLUG-IN UNITS.

3-41. The Model 180C/D Oscilloscope requires time base and vertical or sampling plug-in units. The deflection sensitivity of the CRT may vary slightly with different units. Vertical plug-ins should be calibrated when first installed or when shifted between oscilloscopes. The time

base and vertical plug-ins must be locked together prior to insertion into the Model 180C/D. Consult the respective plug-in operating and service manuals for operation and capability information. Table 3-1 lists the plug-ins currently available.

3-42. PHASE MEASUREMENT.

3-43. Channel B of multichannel vertical plug-ins should be used when making phase measurements. When a different channel (other than B) is to be used, the oscillo-

Table 3-1. Available Plug-ins

VERTICAL AMPLIFIER PLUG-INS								SAMPLING
Model No.	1801A	1802A	1803A	1804A	1806A	1807A	1808A	1810A
Bandwidth (MHz)	50	100 (75 cascaded)	40 (30)	50	0.5	35	75	1 GHz
Min. deflection factor/div	5 mV (500 uV opt. 001)	10 mV (1 mV cascaded)	5 mV (1 mV)	20 mV	100 uV	10 mV	5 mV	2 mV
Channels	2 (1 cascaded opt. 001)	2 (1 cascaded)	1	4	2	2	2	2
Differential Input	Yes	Yes	Yes (with dc offset)	No	Yes	Yes	Yes	Yes

TIME BASE PLUG-INS					SAMPLING/TDR	
Model No.	1820A	1820B	1821A	1822A	1810A	1815A/1815B
Ext. trig	100 MHz	150 MHz	100 MHz	150 MHz	> 1 GHz	35 ps calibrated TDR and 12.4 GHz sampling
Int. trig	75 MHz	120 MHz	75 MHz	120 MHz	1 GHz	Requires Sampling head and tunnel diode.
Sweep Speed/div	5 ns-2s (24 ranges)	5 ns-2s (24 ranges)	10 ns-1s (22 ranges)	5 ns-1s (23 ranges)	100 ns (expanded) —50 us	
Delayed and mixed sweep	No	No	Yes	Yes	No	

scope horizontal amplifier should be properly adjusted for that channel. Section V of this manual contains the adjustment procedure. Accurate phase measurements may be made at frequencies up to 100 kHz.

3-44. To measure phase, set the internal PHASE/BANDWIDTH switch to PHASE and connect the input signals to the vertical amplifier Channel B input and the oscilloscope HORIZONTAL EXT INPUT. Set the HORIZONTAL DISPLAY to EXT. A display similar to Figure 3-2 will be observed. The size of the opening of the display is a relative indication of the phase difference of the input signals.

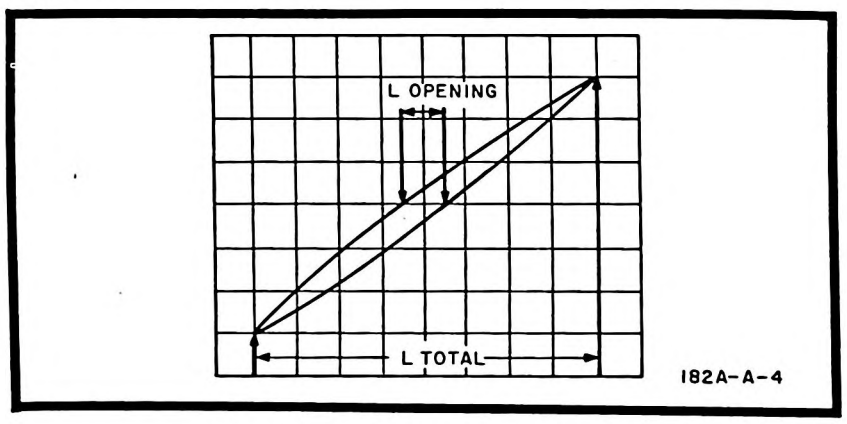


Figure 3-2. Phase Measurement

3-45. To obtain a more exact measurement of the phase difference, center the display in the X-axis and Y-axis. Increased measurement accuracy will be obtained by using horizontal and vertical deflection factors which result in maximum display size. The phase shift in degrees is determined by the following:

$$\emptyset = \sin^{-1}\left(\frac{L\ \text{opening}}{L\ \text{total}}\right)$$

3-46. As an example, assume that L total is 8 divisions. If L opening is 1 division, the phase shift is approximately 7 degrees.

Note

Make certain that the switch is returned to BANDWIDTH position after making phase measurements. This will allow full horizontal bandwidth operation.

3-47. BRIGHT DISPLAY PHOTOGRAPHY.

3-48. The standard CRT (aluminized P31 phosphor) used in the Model 180C/D has an accelerating potential of approximately 15 kV. This provides a bright display and makes possible a very high measurement capability of low duty cycle signals. Photographic writing speed is at least 1500 centimeters/microsecond using standard 10,000 ASA Polaroid ® film, HP Model 195A Camera (F1.3, 1:0.5 object-to-image ratio) without employing film-fogging techniques.

3-49. Higher writing speeds are readily achieved by using film-fogging techniques, a CRT with P11 phosphor, and a camera with faster lenses. Additional information is provided in the following paragraphs and more detailed data can be obtained from Application Note 115, Principles of Cathode-ray Tubes, Phosphors, and High-speed Oscillography, available on request from HP Sales/Service Office.

3-50. PHOTOGRAPHIC WRITING SPEED.

3-51. The capability of an oscilloscope-camera-film system to record a high-speed one-time signal is described as the writing speed of the system. Many factors affect this performance. Basic information which will assist the operator in achieving the maximum capability of the system is provided here.

3-52. FILM. Type 410 Polaroid film has an ASA speed index of 10,000. This is an ultra high-speed film which is particularly useful for single-shot oscilloscope recording. The film is a high contrast type and produces very useable photographs for examination or reproduction. Its extreme sensitivity is helpful in recording the low light level obtained from CRT display of a very high speed transient waveform.

3-53. CRT SPOT SIZE AND SPEED. Uniformity of spot size over the CRT display area will result in best resolution and detail. The oscilloscope focus and astigmatism controls should be adjusted to obtain the sharpest spot for the intensity setting required.

3-54. Trace focus can vary at different sweep speeds. Oscilloscope focus should be set at the sweep speed and intensity level which will be used to display the signal to be photographed. When photographing a single-shot signal, the focus can be set by using a test signal input having a repetition rate of less than 10 milliseconds. As the speed of the spot increases, more exposure time or a higher intensity display may be required for film recording of the signal.

3-55. EXPOSURE. Evaluation of the signal to be photographed may make it desirable to overexpose one portion of a signal to capture the part which is of greater interest. This occurs because the speed of the spot (ie: spot writing speed) very directly affects the light output of the CRT. As an example: if the risetime of a fast pulse is the detail desired, display and photographic parameters could be set to capture this, while the flat-top portion might be overexposed and its detail uncertain. This occurs since the spot speed would be high for the risetime portion of the pulse and slower over the flat top portion.

3-56. CRT INTENSITY. The intensity level used to present a display for viewing or photography has a great effect on the oscilloscope writing rate and the proper photographic exposure. Small changes in intensity levels are usually compensated for by the overall range of film latitude. This results in a good exposure within a fairly wide range of exposure variables.

3-57. SINGLE SHOT. Signals of extremely short duration will require use of a high intensity level. The fast writing rate of the Model 180C/D is ideal for displaying single-shot signals. As a general rule, extended exposure times sufficient to make use of the phosphor after-glow will assist in recording very short duration signals.

3-58. CAMERA FOCUSING.

3-59. Make certain that the camera is focused properly, since decreased writing speeds will result from a defocused film image. The CRT calibration graticule is internally etched on the viewing face, and the trace and graticule are in the same object plane. Focusing the camera accurately on the graticule will provide the sharpness desired.

3-60. If it is necessary to use a large lens aperture, the depth of field is reduced and accurate focusing can become an important factor.

3-61. FILM POST-FOGGING.

3-62. After exposure to the displayed signal, a controlled exposure of Polaroid film to a light source can increase the effective writing speed. At very low light levels, little change in Polaroid film density occurs over considerable variation in light intensity. This occurs because near the threshold of film sensitivity, exposure and the resulting film contrast is a non-linear relationship. Additional exposure to light can effectively increase the low-level sensitivity of the film and provide greater viewing contrast.

3-63. Post-fogging is simple to accomplish with the Model 180C/D. The SCALE control provides this capability. It allows illuminating the CRT phosphor (and contrasting graticule) by flooding the face of the CRT with low-level excitation.

3-64. If the signal to be photographed is very fast, the post-fogging time should be longer than that required for maximum contrast of slower speed signals.

3-65. If desired, photography of the displayed signal and graticule may be accomplished simultaneously. Use of the SCALE control makes it unnecessary to illuminate the graticule by ultraviolet light, as provided in some cameras. It can be turned off, and the SCALE control can be quickly set to provide the desired level of graticule illumination.

3-66. PHOTOGRAPHIC PROCEDURE.

Note

When using high-speed ASA 10,000 film, allow the CRT phosphor to decay for 2 minutes after the camera viewing port is closed and before the photograph is taken. This will allow phosphor excitation by ambient light to decay and prevent film overexposure with long shutter times. (Allow 3 minutes if P11 CRT is installed.)

3-67. REPETITIVE SIGNAL.

a. Adjust Model 180C/D, time base and vertical amplifier controls to obtain the desired signal display.

b. Adjust INTENSITY AND FOCUS for sharpest trace.

c. Adjust SCALE for desired graticule contrast.

d. Expose film using shutter and aperture settings based on type of film employed and camera characteristics.

3-68. SINGLE SIGNAL.

a. Adjust Model 180C/D time base and vertical amplifier controls to obtain the desired signal display using a test signal to establish vertical deflection, trigger control and sweep time settings.

b. Adjust INTENSITY and FOCUS for sharpest trace. Use a low repetition rate signal or single-shot signal in single-sweep operation while making these adjustments so that best approximation of the desired signal parameters is obtained.

c. Set camera controls for desired operation, usually time or bulb.

d. Open camera shutter and allow sweep to trigger on signal.

e. Adjust SCALE control for desired level of graticule illumination and post-fog film if necessary for extremely fast signals. A very low level of illumination, small lens opening and fast shutter speed will provide adequate post-fogging.

Note

Increased writing speed can also be obtained by a controlled exposure of Polaroid film to a light source before exposure to the displayed signal. This is called pre-fogging. Either post-fogging or pre-fogging techniques may be used. Results are approximately equivalent.

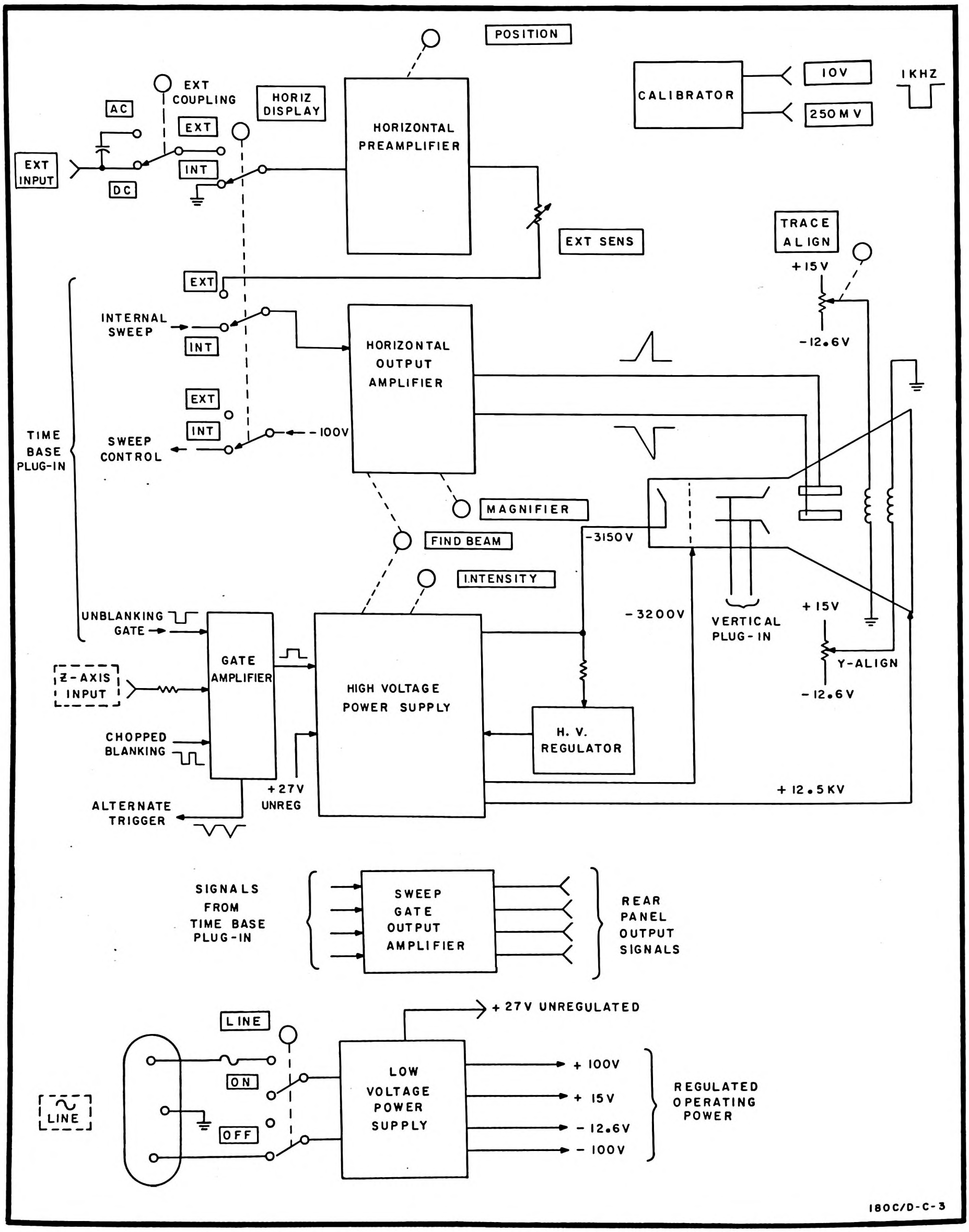


Figure 4-1. Model 180C/D Block Diagram

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section provides information about the circuits used in the Model 180C/D and how they operate. Refer to the overall block diagram (Figure 4-1) and the schematics in Section VIII while reading the text.

4-3. GENERAL DESCRIPTION.

4-4. The Model 180C/D is an X-Y axis display instrument designed to be used with a plug-in vertical amplifier and a plug-in time base generator, a sampling plug-in or a TDR plug-in. The instrument contains the CRT and its controls, the low voltage and high voltage regulated power supplies, a horizontal amplifier, and a gate amplifier. A sweep-gate output amplifier and a calibrator are also included.

4-5. To obtain a useful display on the CRT, three internal signals are necessary: vertical deflection, horizontal deflection, and intensity. The signal required for vertical deflection (Y-axis) of the CRT is supplied from a plug-in vertical amplifier. This signal is connected directly from the vertical plug-in to the CRT vertical deflection plates. The horizontal (X-axis) deflection signal is generated by the time base plug-in. It is further amplified by the oscilloscope horizontal amplifier in the mainframe before being applied to the CRT horizontal deflection plates.

4-6. The signal for CRT intensification must be time coincident with the horizontal deflection signal to increase the CRT brightness as the beam is swept through the CRT display area. This intensity determining signal is called the unblanking gate. It is developed in the time base plug-in and amplified by the gate amplifier for application to the CRT control grid.

4-7. Signals for horizontal deflection and intensity modulation may also be applied to the oscilloscope from external sources other than the plug-in units. External input jacks are provided for this purpose.

4-8. INPUT POWER.

4-9. Either 115V or 230V ac (±10%), single phase, 48 to 440 Hz can be applied as operating power. A rear-panel SELECTOR switch allows operation from either input line voltage. This switch connects two windings of the instrument power transformer in parallel for 115V operation. The windings are placed in series for 230V operation.

4-10. With power applied to the power transformer primary windings, several secondary voltages are produced. Rectified, filtered and regulated as required, they are used as the source of power for the various circuits of the oscilloscope and for operation of the vertical and time base plug-ins.

4-11. HORIZONTAL DEFLECTION.

4-12. The horizontal amplifier may be used with either internal or external deflection signal sources. Positioning the DISPLAY switch to INT arranges the circuitry to operate from signals supplied from time base plug-in. In this condition, −100V power is applied to the time base plug-in, allowing it to operate and produce both a sweep signal and an unblanking gate signal.

4-13. The sweep signal from the time base plug-in is coupled to the oscilloscope horizontal output amplifier. Here it is converted to a differential signal, amplified, and applied to the CRT horizontal deflection plates.

4-14. Horizontal position of the X-axis sweep signal is controlled at the input to the first stage of the horizontal output amplifier. Two potentiometers are used to provide fine and coarse positioning control.

4-15. Horizontal amplifier gain is controlled by the MAGNIFIER switch. Three settings can be selected: X1, X5, or X10. With X1 selected, the sweep speed corresponds to the selected time base plug-in sweep speed. In X5 operation, the sweep speed is five times that selected at the time base plug-in; while in X10, the sweep speed is ten times that selected at the time base plug-in.

4 16. The unblanking gate from the time base plug-in is coupled to the gate amplifier where it is summed with the Z-axis input and chopped blanking signals (if they are applied). The resulting signal is amplified and coupled through the high voltage supply to the CRT control grid to set the intensity of the displayed signals.

4-17. At the end of each unblanking gate, the gate amplifier produces an alternate trigger signal. This signal is coupled to the vertical plug-in and is a negative-going pulse. The alternate trigger is used by the vertical plug-in to synchronize the channel switching of multichannel vertical plug-ins.

4-18. With the DISPLAY switch set to EXT, operating power (−100V) is removed from the time base plug-in. Without this −100V, the time base plug-in does not produce an internal sweep signal or an unblanking gate. The vertical amplifier plug-in operates normally.

4-19. An externally applied signal for horizontal deflection may be connected to the EXT INPUT jack. The EXT SENS controls the externally applied signal and provides a variable gain adjustment for setting the X-axis display size. The external coupling switch provides for either direct (DC) or capacitive (AC) coupling of the external input signal. The external signal is then coupled to a preamplifier, differentially amplified by the output amplifier, and applied to the CRT for horizontal deflection. Positioning and horizontal gain controls also function with external input signals.

4-20. CIRCUIT DETAILS.

4-21. INPUT POWER (SCHEMATIC 2).

4-22. Input line power is supplied by a detachable, three-conductor power cord. This cord has a standard plug for wall outlet connection, providing an electrical ground. Instrument power input is via a rear-panel IEC connector. Both sides of the line power are filtered immediately at the power input connector.

4-23. The line power transformer has two primary windings. The rear panel SELECTOR switch connects these windings in parallel for 115V operation and in series for 230V operation. Fuse F1 protects against excessive input current. When changing line voltage, the fuse must be changed. With the front panel LINE toggle switch S1 in the ON position, power is applied to the low voltage power supply transformer and LINE lamp DS1 lights.

4-24. LOW VOLTAGE POWER SUPPLY (SCHEMATIC 2).

4-25. The low voltage supply produces four regulated voltages for use throughout the oscilloscope and the plug-ins: +100V, −100V, +15V and −12.6V. Each supply is referenced to the +100V supply for regulation purposes with the +100V supply referenced to a 9-volt temperature-compensated zener diode A1A2VR2. The +100V and −100V supplies are also foldback current limited, providing short-circuit protection.

4-26. A simplified block diagram of a typical low voltage power supply is shown in Figure 4-2. Unregulated alternating power is supplied by the transformer, bridge rectified and filtered. Changes in output voltage caused by input voltage variation or load changes are detected by the voltage sensor. Compared against a voltage reference, changes in output voltage are detected and applied as feedback to the driver which controls the series regulator. The series regulator acts as a variable resistance, and operates to increase its series resistance if the output voltage is high or decrease resistance when the output voltage is low. The action of the series regulator is to maintain output voltage at a constant level.

4-27. Current sensing takes place simultaneously with voltage sensing. If the load current increases above a preset level, the current sensor detects the increased voltage drop across the series resistor. This increased voltage causes the driver to bias the series regulator off.

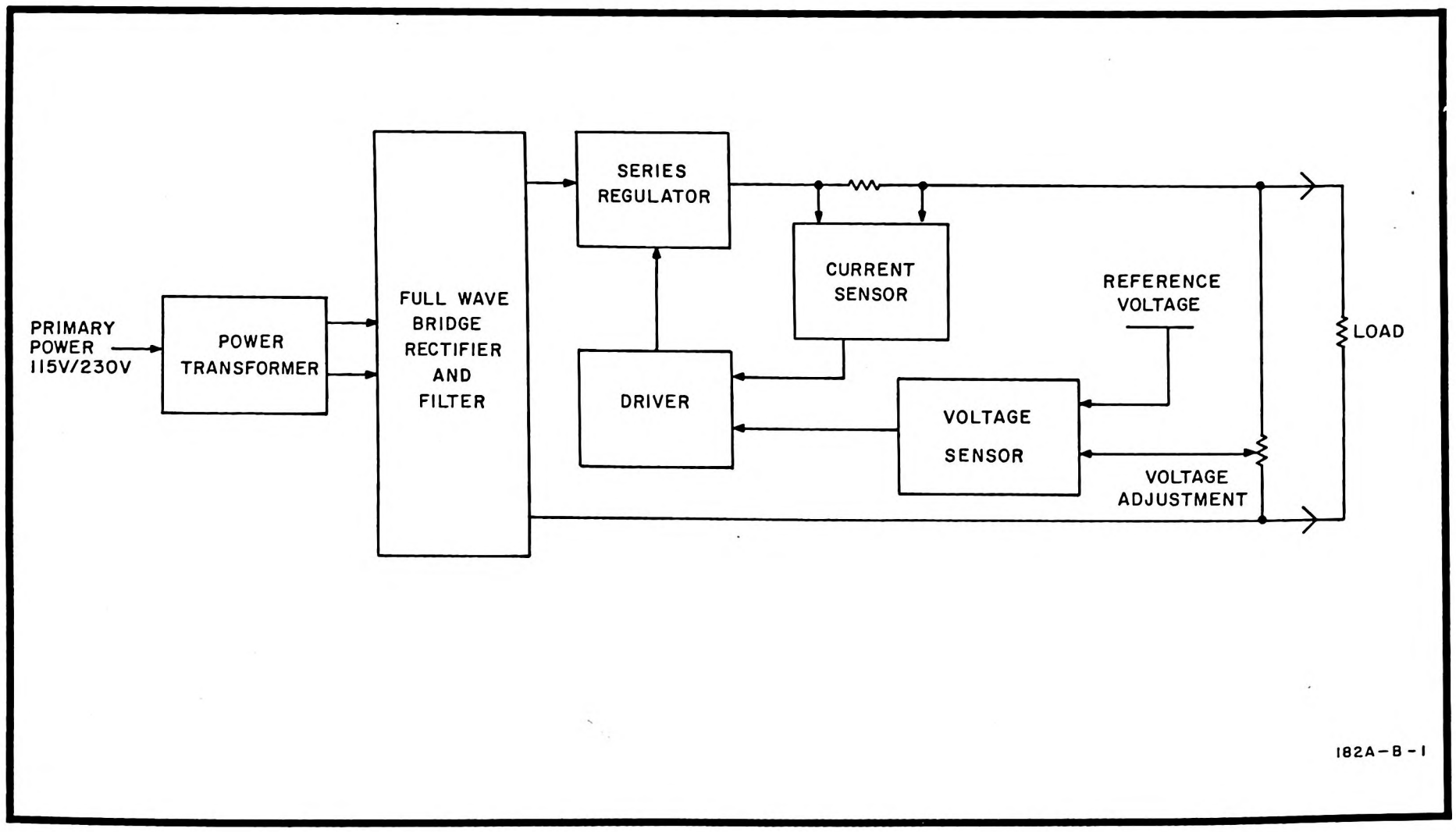


Figure 4-2. Simplified Low Voltage Power Supply

4-28. +100-VOLT SUPPLY. The +100V supply is used throughout the LVPS as a reference for the other supplies. It is both voltage and current regulated. Refer to the LVPS schematic while reading the following explanation.

4-29. One of the secondary outputs of A1T1 is coupled to a bridge rectifier consisting of A1A1CR5-CR8. This ac input is full-wave rectified, filtered by A1C1, and applied through fuse A1F1 to the regulator assembly. Fusing protects the rectifiers and transformer if a regulator malfunction results in excessive current flow. The regulator supplies sufficient current to the load to keep the output voltage at a constant +100 volts. Series regulator transistor A1Q1 is used to determine the amount of current which will be supplied to the load to maintain the output voltage at +100V. Variations in output voltage to changes in load or input line voltage are sensed by a differential comparator, A1A2Q3 and A1A2Q4. If the output of the +100V supply changes, the full amount of the voltage change is applied to A1A2Q3 by A1A2VR2, and A1A2Q4 senses only a small part of the change in output voltage. The +100V adjustment potentiometer A1A2R11 sets the operating point of A1A2Q4. The output of the differential comparator is coupled to driver A1A2Q1, amplified and used to control series regulator A1Q1.

4-30. A current limiting function is also part of the +100V supply operation. All current furnished by the supply flows through A1A2R4. The voltage drop across this resistor depends on the amount of current required. As the current requirements increase to the limit of the supply capability, the voltage drop across A1A2R4 is used to set A1A2Q2 into conduction. Since the collector of this transistor and the output of differential comparator A1A2Q2 and A1A2Q4 are coupled to drive A1A2Q1, the amount of current flowing, as well as voltage variations, controls the operation of series regulator A1Q1.

4-31. Resistors A1A2R2 and A1A2R3 are used in conjunction with A1A2R4 to set up a condition for current foldback operation. In this type of operating condition, fully regulated voltage will be provided to the limit of the supply capability. When current requirements exceed capability, the output voltage will begin to drop and the load will receive less current. If the output of the supply is short-circuited, the output current will be limited to considerably less than the current available at full loading.

4-32. The +100V supply is protected for turn-on and turn-off voltage transients. Diodes A1A2CR1 and A1A2CR2 provide transient protection for the differential amplifier, A1A2Q3 and A1A2Q4. To prevent the +100V supply from going negative in the event of an accidental short circuit, diode A1A2CR3 provides reverse voltage protection.

4-33. A separate supply is used to obtain a reference voltage for the +100V regulator. This supply is used only within the LVPS regulator. The ac voltage from pins 11 and 12 of A1T1 is bridge rectified by A1A1CR1-CR4 and filtered by A1A1C1. The supply produces about +10V which is added to the +100V supply to provide a reference source for the +100V regulator. Zener diode A1A2VR1 stabilizes the collector voltage for A1A2Q3.

4-34. +15-VOLT SUPPLY. This supply provides three voltages. Approximately 30V p-p is furnished for time base line synchronization; a rectified and filtered but unregulated +27V is furnished for operation of the HV oscillator; and a regulated +15V is produced for use in the mainframe and plug-ins.

4-35. The secondary voltage developed by the power transformer at pins 13 and 14 is full-wave bridge rectified by A1A2CR9-A1A2CR12 and filtered by A1C2. Diode A1A1CR21 provides reverse voltage protection. Series regulator A1Q2 determines the amount of current supplied to the load to maintain the output voltage at +15V. Variations in output voltage are sensed by differential comparator A1A2Q7 and A1A2Q8. A reference voltage derived from the +100V regulated supply is applied to A1A2Q7, while A1A2Q8 samples any change in output voltage due to load changes. The +15V adjustment potentiometer A1A2R20 sets the operating point of A1A2Q8. The output of the differential amplifier is coupled to driver A1A2Q5 and used to control the series regulator.

4-36. Current drawn from the supply flows through A1A2R13. The voltage drop across this resistor is used to control the conduction of A1A2Q6, which has its collector coupled to driver A1A2Q5. Thus, large currents sensed by A1A2Q6 and voltage changes sensed by the differential amplifier are both fed to the driver, A1A2Q5, to control series regulator A1Q2. Protection from turn-on or turn-off transients is provide by A1A2CR4. Fuse A1F2 protects the LV rectifier and transformer in the event of a regulator short circuit.

4-37. −12.6-VOLT SUPPLY. This supply operates in a manner similar to the +15V supply. Changes in output voltage are sensed by differential comparator A1A2Q11 and A1A2Q12. Amplified and coupled to driver A1A2Q9, voltage variations are used to control the conduction of series regulator A1Q3. Current limiting action is provided by A1A2R22 and A1A2Q10. Fuse A1F3 protects against damage due to regulator failure and A1A2CR5 is used for voltage transient protection.

4-38. −100-VOLT SUPPLY. Operation of the −100V supply is similar to the +100V supply. A1A2Q15 and A1A2Q16 operate as a differential comparator with A1A2Q16 sensing any change in output voltage. Transistor A1A2Q14 with A1A2R33 provides current limiting. Current foldback operation reduces the current output in the event of a short circuited load. Voltage and current variations are coupled to driver A1A2Q13 which is used to control the conduction of series regulator A1Q4. Adjustment of the supply output voltage is accomplished with potentiometer A1A2R40, and diode A1A2CR7 provides reverse voltage protection. The differential comparator is voltage transient protected by A1A2CR6.

4-39. SUPPLY CURRENT AVAILABLE. The oscilloscope power supplies may be used to furnish operating power for vertical or time base plug-ins designed by the user. Table 4-1 lists the maximum current available from each power supply to the plug-in compartment of the oscilloscope. There is no minimum current requirement for any supply.

Table 4-1. LVPS Current Capabilities

Power Supply	Maximum Safe Current Available
+100 VDC	160 mA
+15 VDC	750 mA
−12.6 VDC	750 mA
−100 VDC	80 mA

4-40. GATE AMPLIFIER (SCHEMATICS 4 and 5).

4-41. The inputs to the gate amplifier are an unblanking gate from the time base plug-in, a chopped blanking signal from the vertical amplifier plug-in and an external input Z-axis signal. These three signals may be present singly or simultaneously, depending on control settings and signals applied. (See Figure 4-3.)

4-42. The unblanking gate is combined in the low impedance emitter circuit of A3Q1 with a current established by the INTENSITY, FIND BEAM, and DISPLAY front-panel controls. Depressing FIND BEAM supplies enough additional current to produce a maximum intensity beam. Setting DISPLAY to EXT supplies additional current from the −100V supply. This establishes an unblanking current level to compensate for removal of the internal unblanking signal from the time base plug-in, and establishes a nominal brightness level.

Note

The intensification function of the FIND BEAM switch is removed on instruments with a P11 phosphor CRT (Option 011 and Option 611). Additional information is provided in Section VII.

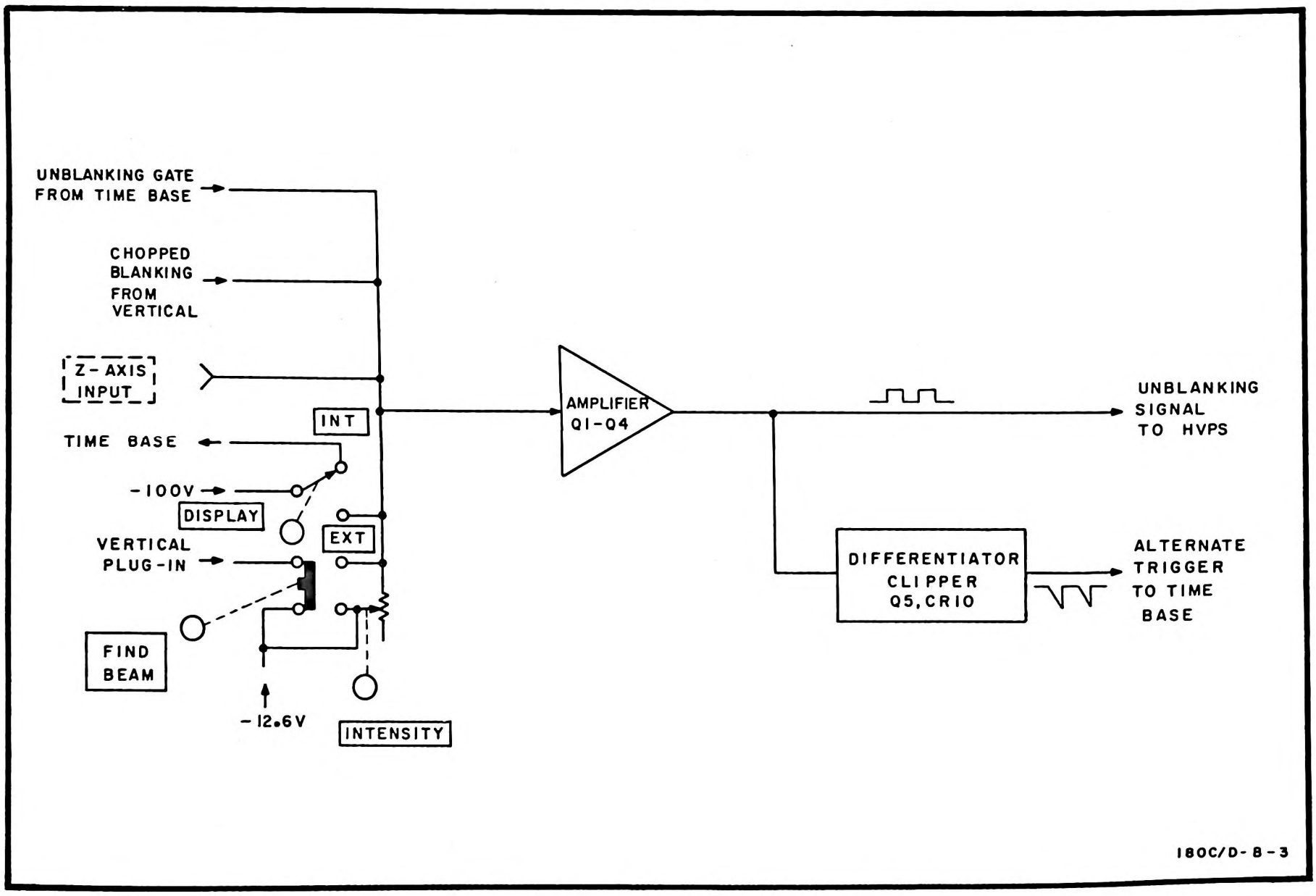


Figure 4-3. Gate Amplifier Block Diagram

4-43. The output of A3Q1 is coupled to a complementary feedback amplifier, converted to a voltage, and coupled through the high voltage power supply for application to the CRT control grid. The CRT control grid high voltage supply is stacked on the output of the gate amplifier, and a change in the amplifier output voltage causes the CRT grid voltage to change accordingly. Amplifier voltage gain is approximately 7 for Z-axis signals.

4-44. A large negative feedback from the collectors of A3Q3 and A3Q4 ensures that the amplifier gain is very stable. Capacitors A3C3 and A3C5 provide for adjustment of the high frequency feedback and gain. Decreasing the capacitance of A3C3 decreases the high frequency feedback and increases high frequency gain, while decreasing the capacitance of A3C5 increases high frequency feedback and decreases high frequency gain.

4-45. Diodes A3CR1 through A3CR4 provide a clamping action to avoid overdriving the amplifier. Complementary amplifier transistors A3Q3 and A3Q4 are protected from the high voltage present at the CRT control grid circuit. Diodes A3CR6 through A3CR9 act to isolate these transistors in the event of high voltage transients which might otherwise be fed back and damage the transistors.

4-46. An alternate trigger signal is used by multichannel vertical amplifier plug-ins to initiate channel switching action. A portion of the output of A3Q3 is differentiated, clipped, and used to provide the alternate trigger signal. A3C9, A2R19 and A2R20 differentiate the signal. Coupled through emitter follower A2Q5, the positive-going part of the signal is clipped by A2CR10. The output provides a negative-going voltage pulse for vertical amplifier channel switching.

4-47. Z-AXIS INPUT. The input impedance to the Z-axis is approximately 5100 ohms. An input signal of approximately +2 volts amplitude is adequate to blank a trace of normal viewing intensity, while an input signal of −2 volts will provide unblanking. Since the gate amplifier has a Z-axis voltage gain of about 7, a 2-volt input will result in a 14-volt change at the CRT grid. This is sufficient to cause a large intensity change.

4-48. HIGH VOLTAGE POWER SUPPLY (SCHEMATIC 5).

4-49. The HVPS generates three regulated voltages. These are applied to the cathode (−3150V), control grid (≈−3200V), and post accelerator (+12.5 kV) of the CRT to provide the accelerating potential required to produce excitation of the CRT phosphor for a visible trace. All three voltages are regulated by sampling the −3150-volt supply.

4-50. The HVPS is shown in simplified form in Figure 4-4. See this figure and schematic 5 in Section VIII while reading the following explanation of HVPS operation.

4-51. HIGH VOLTAGE OSCILLATOR. Transistor Q1 with transformer A5T1 is used as an oscillator to generate an ac voltage at approximately 50 kHz. A feedback winding on the transformer provides the regenerative coupling to sustain oscillation. Operating power is provided by the unregulated +27V supply. The supply source is fused and decoupled.

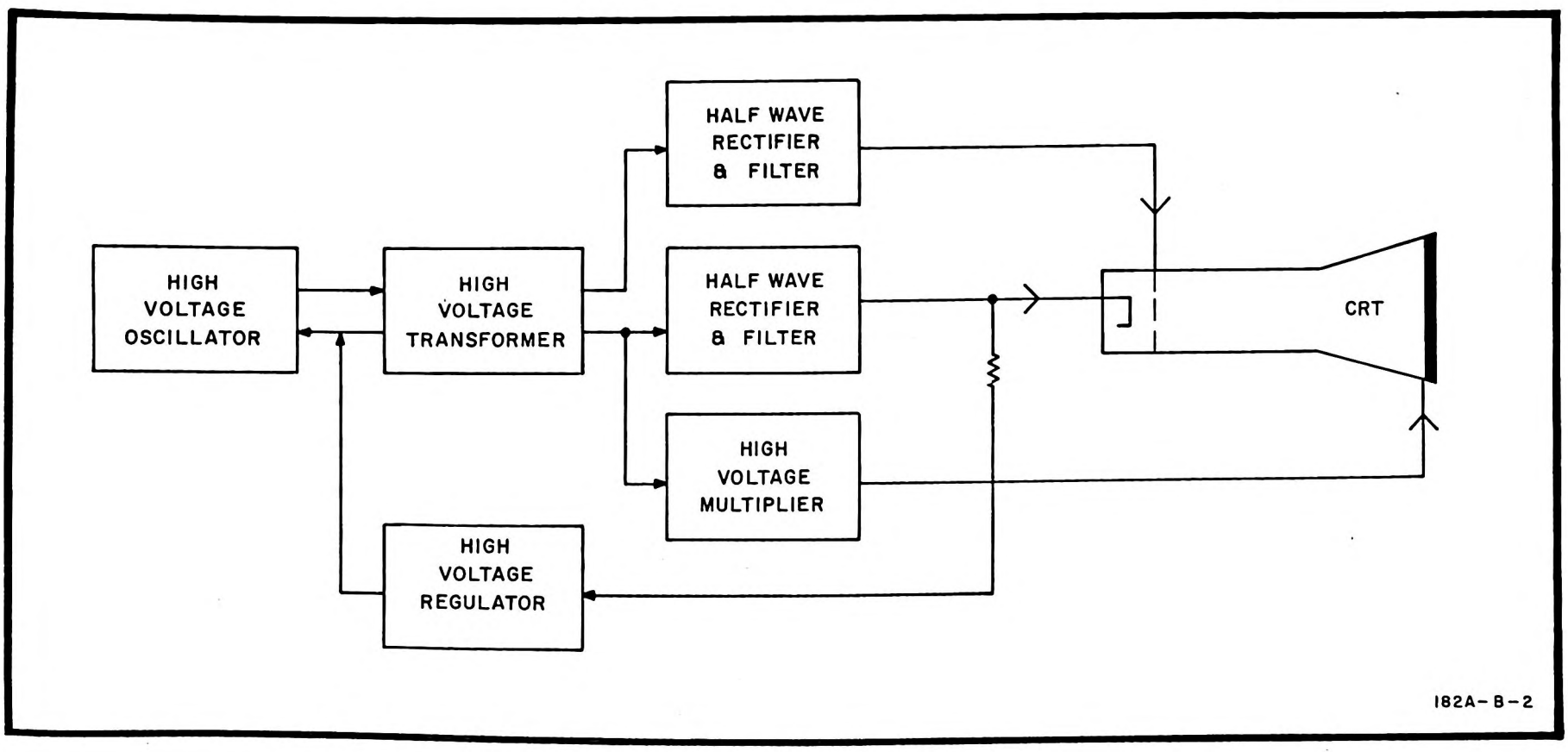


Figure 4-4. High Voltage Power Supply Block Diagram

4-52. HIGH VOLTAGE RECTIFIERS. The oscillator 50 kHz output is stepped up by the secondary windings of A5T1. Two half-wave rectifiers and a voltage multiplier circuit are used to develop the high voltages necessary for CRT operation.

4-53. CRT grid voltage is rectified by A5CR1 and the pulsating dc is filtered. The lower limit of display intensity, as determined by the CRT grid voltage, is set by A5R2. Approximately –3200V is developed for application to the CRT grid.

4-54. A secondary winding of A5T1 is used as the high voltage source for the CRT cathode and the CRT post accelerator. The full potential developed by the winding is rectified and filtered by the H.V. Multiplier assembly, A6, for application to the CRT post accelerator. This assembly develops approximately 12.5 kV.

4-55. The full secondary voltage is also rectified by A5CR2, filtered, and applied to the CRT cathode. The H.V. regulator is adjustable to ensure that cathode voltage is maintained at –3150V. To eliminate cathode to filament breakdown, the filament is brought to cathode potential by R4. A3VR3 and A3VR4 prevent the grid from becoming positive in relation to the cathode.

4-56. HV REGULATION. A portion of the rectified and filtered CRT cathode voltage is used to control the conduction of A3Q8. The –3150V cathode potential and the +100V supply are applied across a resistor network consisting of A3R51, A3R48 and A3R49. The bias of A3Q8 is adjusted by A3R49. Any variation of the –3150V supply is sensed by A3Q8 and amplified by A3Q9 and A3Q10. The regenerative feedback winding of A5T1 for high voltage oscillator Q1 sets the base bias level of Q1. This controls the amplitude of oscillation.

4-57. The regulator output, as set by A3R49 and controlled by the divided output of the –3150V supply, is used to control the operating level of the oscillator through the feedback winding of A5T1. Thus, any variation in the high voltage output is used to vary the oscillator drive and maintain all high voltage outputs at a constant level.

4-58. If, for example, the CRT cathode voltage tends to decrease (go more positive), a positive-going signal is applied through the regulator to the base of oscillator Q1. The oscillator then conducts for a greater period of time, causing a large voltage change at the primary of A3T1. This increases the secondary voltage to restore cathode voltage to the desired level.

4-59. CALIBRATOR (SCHEMATIC 4).

4-60. The calibrator uses a free-running multivibrator whose output is a 1-kHz square wave. A voltage divider provides the output at two amplitudes: 10 volts and 250 millivolts. The calibrator output is a negative-going waveform.

4-61. Transistors A3Q6 and A3Q7 oscillate at a rate which is determined by the time constant of associated RC components. A3CR11 disconnects the collector of A3Q7 from the negative discharge of A3C15 as A3Q7 cuts off. This provides a faster risetime. Diodes A3CR12 and A3CR13 protect the transistors from voltage breakdown. A filter network, A3L2 and A3C16, isolates the the multivibrator from the –100V supply.

4-62. With A3Q7 conducting, the voltage divider consisting of A3R34, A3R36, and A3R35 divides the –100V supply voltage. The values selected for these resistors permit the output of 10V and 250 mV. These two outputs are available at the instrument front panel and may be used for probe compensation adjustment and horizontal or vertical deflection factor checks.

4-63. SWEEP GATE OUTPUT AMPLIFIERS (SCHEMATIC 7).

4-64. The output amplifiers are four emitter followers, A7Q1-A7Q4. They provide isolated outputs of time base, sampling, or TDR generated signals to rear-panel connectors. The operating and service manual for the plug-in will provide information on the characteristics of the output signals.

4-65. The four time base signal inputs to these amplifiers are the main sweep, delayed sweep, main gate, and delayed gate. The emitter followers convert the high impedance inputs to low impedance outputs and isolate the time base signals from external equipment.

4-66. HORIZONTAL AMPLIFIER (SCHEMATIC 3).

4-67. The input to the horizontal amplifier is either an internal sweep signal from the horizontal plug-in or an external signal applied to the HORIZONTAL EXT INPUT jack. Positioning DISPLAY to INT grounds the input of the preamplifier and disconnects the external signal preamplifier from the output amplifier. The internal sweep signal is connected through the horizontal DISPLAY switch to the output amplifier. (See Figure 4-5.)

4-68. Selecting horizontal DISPLAY EXT disconnects the internal sweep signal and connects the external signal through the preamplifier to the output amplifier. With EXT selected, the amplitude of the signal from the preamplifier is adjustable by rotating the EXT SENS control. When the control is in the EXT CAL detent position, the output amplitude of the amplifier is directly determined by the input amplitude.

4-69. The selected signal is applied to the output amplifier and summed with a current established by the horizontal POSITION and FINE controls. A horizontal MAGNIFIER allows the gain to be increased by a factor of 5 (X5), a factor of 10 (X10), or to be directly related to the amplitude of the input signal (X1). The resulting current is converted to a differential voltage signal, amplified, and applied to the horizontal deflection plates of the CRT.

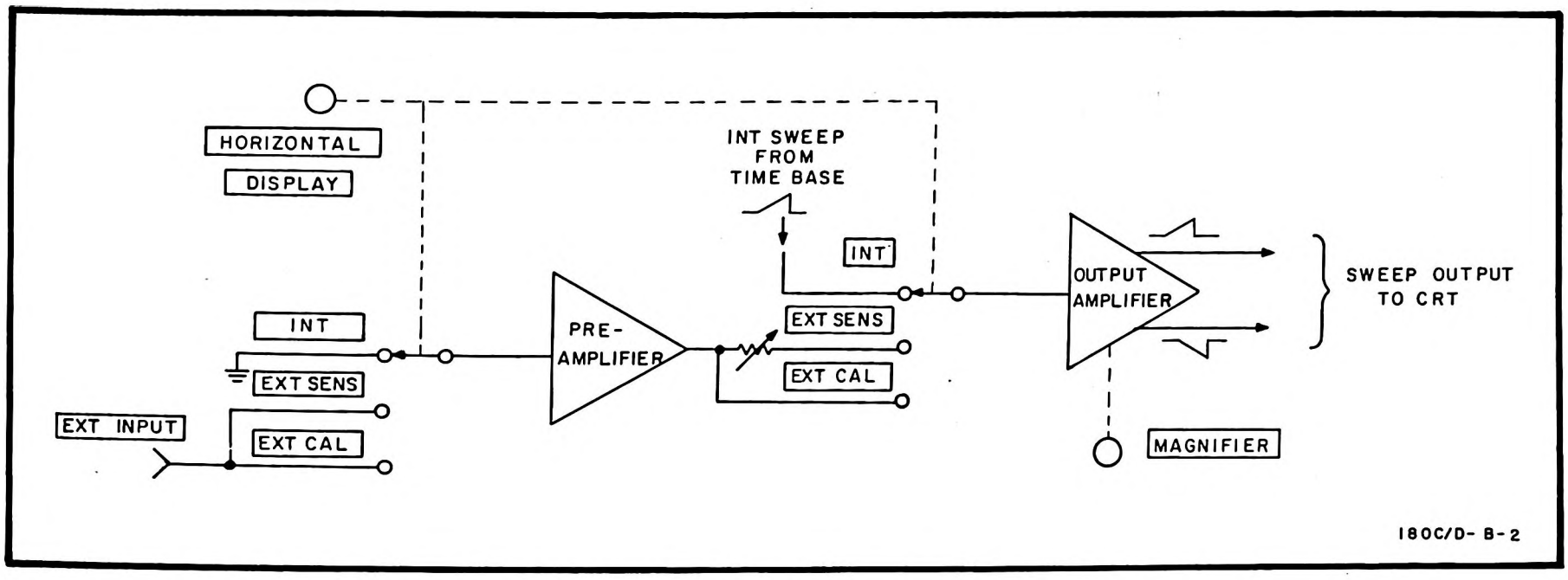


Figure 4-5. Horizontal Amplifier Block Diagram

4-70. Refer to the schematic of the horizontal amplifier for the more detailed circuit explanation which follows.

4-71. An external signal applied to the preamplifier is coupled through a 3:1 divider composed of A2R4 and A2R6 to the gate of an FET, A2Q1. The high input impedance of A2Q1 in conjunction with the voltage divider and A2R5 provides a 1-megohm load to the external circuit. Transistor A2Q2 is an emitter follower. The output of A2Q2 is coupled through the horizontal EXT SENS control and the horizontal DISPLAY switch. The amount of current supplied to A2Q3 is determined by A2R12 and the setting of the EXT SENS control.

4-72. The bandwidth of the preamplifier is decreased when the Phase/Bandwidth switch is placed in the Phase position. This is accomplished by connecting A2C8 and A2C9 into the circuit. The phase shift caused by the decreased bandwidth compensates for the signal time delay from the delay line in the vertical amplifier plug-in. This allows accurate X-Y phase measurements to be made up to 100 kHz.

4-73. A vernier balance adjustment, A2R14, is used to establish a zero input voltage reference level. This eliminates horizontal dc shift as the EXT SENS control is rotated. The EXT SENS provides a range of control of the deflection factor when an EXT INPUT signal is used for horizontal deflection. It has sufficient range to reduce the deflection factor by at least 10.

4-74. The input signal to A2Q3 is summed in the low impedance emitter circuit with a current established by the horizontal POSITION and FINE controls. The output of A3Q3 has both a static dc level as determined by the POSITION and FINE controls and an active level as determined by the input signal.

4-75. The output of A2Q3 is coupled through emitter follower A2Q4 to differential amplifier A2Q5 and A2Q6. The low impedance necessary to drive A2Q5 is provided by A2Q4, and A2Q9 maintains a similar low impedance voltage source for A2Q10.

4-76. The position of the MAGNIFIER switch, S3, selects between three values of emitter degeneration for A2Q5 and A2Q10 and controls the gain of these stages. As degeneration decreases, gain increases. The gain selection is accomplished by the setting of the MAGNIFIER control, with settings of X1, X5, and X10. Each has an adjustable element to provide for accurate calibration of the gain. With X1 magnification selected, A2R36 is used to set the gain. A2R34 sets the gain in X5, and A2R32 sets the X10 gain. The emitter potentials of A2Q5 and A2Q10 are balanced by A2R38. This prevents horizontal dc shift as the MAGNIFIER control is switched between ranges.

4-77. The differential signal at the collectors of A2Q5 and A2Q10 is applied to current-fed operational amplifiers A2Q6/A2Q7/A2Q8 and A2Q11/A2Q12/A2Q13. The amplifier low frequency gain is very stable because of the large amount of negative feedback employed. High frequency feedback for each side of the amplifier is separately adjustable.

4-78. High frequency feedback from the collectors of A2Q7/A2Q8 to the base of A2Q6 is controlled by A2C12 and high frequency feedback from the collectors of A2Q12/A2Q13 to the base of A2Q11 is controlled by A2C20. The ratio of feedback for each side of the amplifier is adjusted by A2C21. Amplifier output is a voltage which is used to drive the horizontal deflection plates of the CRT.

4-79. Diodes A2CR3/A2CR4 and A2CR7/A2CR8 limit the output to the deflection plates and prevent overdriving. Diodes A2CR2 and A2CR6 prevent A2Q5 and A2Q10, respectively, from saturating.

4-80. Depressing the FIND BEAM control disables diodes A2CR7 and A2CR8 and blocks the signal to A2Q11. The differential gain is effectively cut in half, and the horizontal deflection of the beam is confined to the limits of the CRT.

4-81. POWER SUPPLY DECOUPLING.

4-82. Decoupling networks are used on each etched circuit assembly for the supply voltages. The use of decoupling is important to prevent extraneous signals or noise from being introduced into circuitry from the power supplies or supply leads. Decoupling also prevents transients originating in other circuits from being introduced.

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section provides a performance check procedure to determine if the Model 180C/D is operating within specifications and a procedure for adjustment and calibration. Physical location of the adjustments are shown in a foldout photograph at the end of this section and next to the adjustment procedure.

5-3. TEST EQUIPMENT.

5-4. Recommended test equipment is listed in Table 5-1. Test equipment having the required characteristics may be substituted. Use recently calibrated equipment to ensure proper results.

5-5. PERFORMANCE CHECK.

5-6. The purpose of the performance check is to determine if the instrument is operating within the specifications listed in Table 1-1. This check may also be used as part of an incoming quality assurance inspection, as a periodic operational check or to verify operation after repairs or adjustments have been made.

5-7. It is desirable to do the performance check in the sequence given since succeeding steps depend on control settings and results of previous steps. If desired, the checks may be accomplished individually by referring to the preliminary control settings and the preceding steps.

5-8. A performance check record is included at the end of these checks. As the initial performance check is accomplished, the actual readings should be entered on the form. The form may be removed from the manual and filed for future reference. Readings taken at a later date can be compared with the original performance check results.

5-9. PRELIMINARY SETUP.

5-10. Set line voltage SELECTOR switch, located on rear panel, to desired power line operating voltage (115V or 230V ac). Connect instrument to line power source and apply power by turning LINE power switch ON. Allow fifteen minutes for warm-up. Do not install plug-ins.

5-11. CALIBRATOR CHECK.

a. Set controls as follows:

MAGNIFIER X10

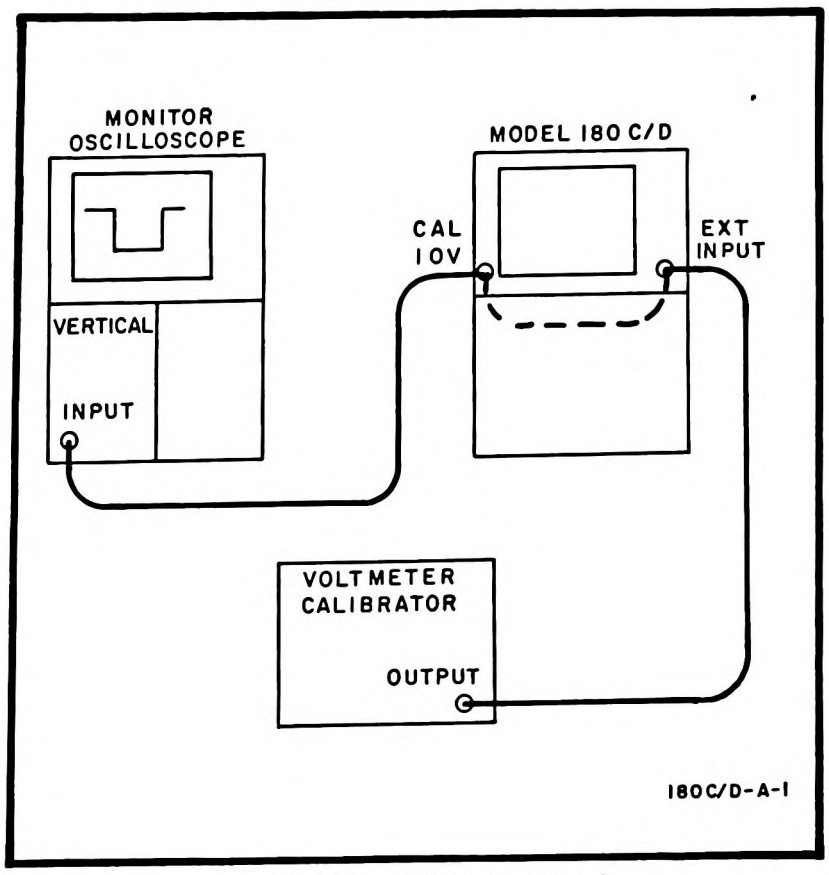


Figure 5-1. Calibrator Check

DISPLAY EXT

HORIZONTAL Coupling AC

b. Connect 10V p-p signal from Voltmeter Calibrator to HORIZONTAL EXT INPUT (Figure 5-1).

c. Obtain horizontal trace by adjusting INTENSITY, FOCUS and POSITION controls.

d. Adjust HORIZONTAL DISPLAY to obtain displayed trace of exactly 10 divisions.

e. Disconnect Voltmeter Calibrator from EXT INPUT. Do not disturb HORIZONTAL DISPLAY.

f. Connect CALIBRATOR 10V output to EXT INPUT.

g. Note displayed trace of 10 ±0.1 divisions. Trace should be set at low intensity to permit viewing sharply focused spots at both ends of trace.

h. Disconnect CALIBRATOR 10V output from EXT INPUT.

i. Observe CALIBRATOR 10V output using Monitor Oscilloscope.

j. Measure risetime of calibrator waveform (negative-going leading edge). It should be 3 usec or less. Risetime is measured at 10% to 90% amplitude points.

k. Disconnect Monitor Oscilloscope.

Table 5-1. Recommended Test Equipment

Instrument		Required Characteristics	Required For
Type	Model		
Voltmeter Calibrator	HP 738 AR, 6920B, or E02-738 BR	1V, 2V and 10V p-p ±0.2%	Calibrator Check Horizontal Magnifier Check
Monitor Oscilloscope	HP 180A/AR w/1801A and 1820A plug-ins	Sensitivity 1 V/div Sweep speed < 3 usec Sweep output	Calibrator Check Gate Amplifier Response Adjustment
10:1 Divider Probe	HP 10004A	±3%	Gate Amplifier Response Adjustment
Constant Amplitude Signal Generator	Tektronix Type 190B/191	50 kHz-50 MHz, 10V p-p	Horizontal Bandwidth Check Horizontal Linearity Adjustment
Digital Voltmeter	HP 3440A w/3441A or 3444A plug-in	±100 Vdc, ±.05%	Low Voltage Power Supply Adjustment High Voltage Power Supply Adjustment
1000:1 Divider Probe	HP K05-3440A	3500 Vdc, ±0.1%	High Voltage Power Supply Adjustment
Square Wave Generator	HP 211B	200 kHz, 1V p-p, risetime ⩽ 30 ns	Transient Response Adjustment
Oscillator	HP 200 CD	10 kHz-100 kHz, 10V p-p	Phase Adjustment Trace Alignment Adjustment
Horizontal Gain Calibrator	HP 10411A	No substitute	Gain Adjustment
Resistor: 40K ohms	HP Part No. 0698-6101	1/10%, 1/2W	Gain Adjustment (Alternate Procedure)
Time Mark Generator	Tektronix Type 184	1-ns markers	Gain Adjustment (Alternate Procedure)
50-ohm Tee	UG294B/U	BNC	Phase Adjustment
Screwdriver	HP 8710-0900	Posidrive	Cover Removal

7000-A-19

5-12. HORIZONTAL MAGNIFIER CHECK.

a. Set controls as follows:

MAGNIFIER X1
DISPLAY EXT CAL

b. Connect 10V p-p signal from Voltmeter Calibrator output to HORIZONTAL EXT INPUT (Figure 5-2).

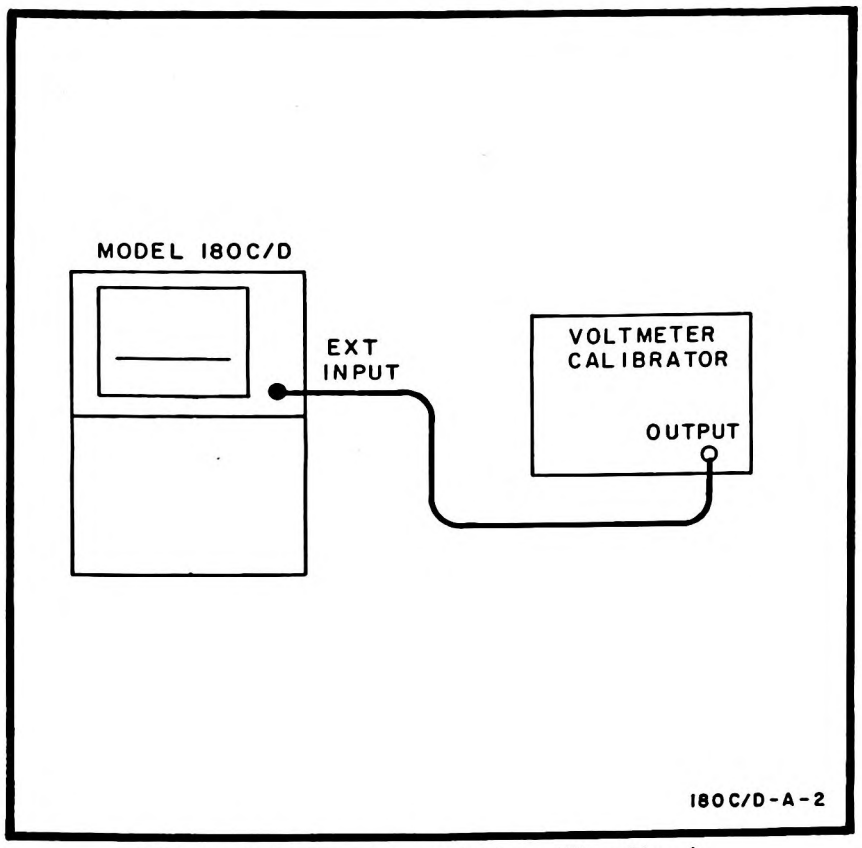


Figure 5-2. Horizontal Magnifier Check

c. Note displayed trace of 10 ±0.5 divisions.

d. Set MAGNIFIER to X5.

e. Set Voltmeter Calibrator for output of 2V p-p.

f. Note displayed trace of 10 ±0.5 divisions.

g. Set MAGNIFIER to X10.

h. Set Voltmeter Calibrator for output of 1V p-p.

i. Note displayed trace of 10 ±0.5 divisions.

j. Disconnect Voltmeter Calibrator.

5-13. HORIZONTAL BANDWIDTH CHECK.

a. Connect 50-kHz signal from Constant Amplitude Signal Generator to EXT INPUT (Figure 5-3).

b. Set MAGNIFIER to X1.

c. Adjust output of Constant Amplitude Signal Generator to obtain displayed trace of exactly 10 divisions.

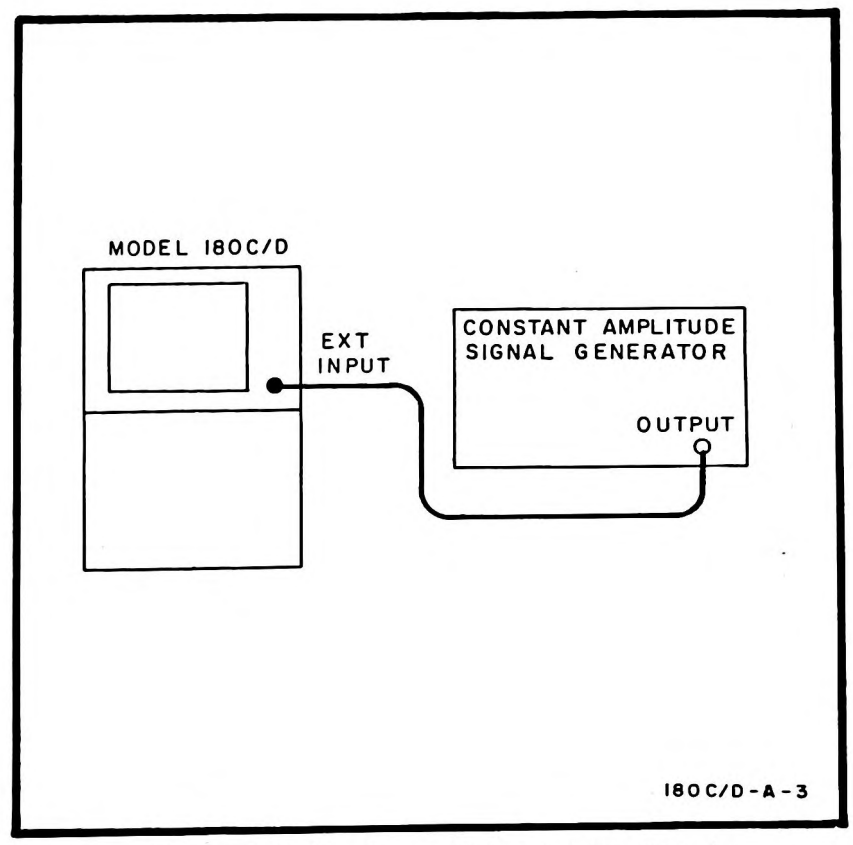


Figure 5-3. Horizontal Bandwidth Check

d. Set Constant Amplitude Signal Generator for output frequency of 5 MHz.

e. Note displayed trace of 7.1 divisions or greater. (If displayed trace is approximately 2 divisions, check position of Phase/Bandwidth switch located in horizontal amplifier. It should be in Bandwidth position.)

f. Set MAGNIFIER to X5.

g. Set Constant Amplitude Signal Generator for output frequency of 50 kHz.

h. Adjust output of Constant Amplitude Signal Generator to obtain displayed trace of exactly 10 divisions.

i. Set Constant Amplitude Signal Generator for output frequency of 5 MHz.

j. Note displayed trace of 7.1 divisions or greater.

k. Set MAGNIFIER to X10.

l. Set Constant Amplitude Signal Generator for output frequency of 50 kHz.

m. Adjust output of Constant Amplitude Signal Generator to obtain displayed trace of exactly 10 divisions.

n. Set Constant Amplitude Signal Generator for output frequency of 5 MHz.

o. Note displayed trace of 7.1 divisions or greater.

p. Disconnect Constant Amplitude Signal Generator.

5-14. BEAM FINDER CHECK.

a. Set controls as follows:

INTENSITY	fully ccw
POSITION	fully ccw

b. Press FIND BEAM pushbutton.

c. Note that intensified beam is displayed.

Note

Option 011 and Option 611 instruments are provided with P11 phosphor CRT. The display intensity will not increase when FIND BEAM is depressed. This eliminates phosphor burn. Use INTENSITY control to set intensity to viewing level.

5-15. This completes the Performance Check. If the instrument does not meet Model 180C/D specifications, the adjustment procedure which follows should be done. If this does not result in satisfactory instrument performance, refer to Section VIII of this manual for troubleshooting and maintenance information.

PERFORMANCE CHECK RECORD
Model 180C/D

Instrument Serial Number _____ **Date** _____

Check	Specification	Measured
CALIBRATOR		
Amplitude	9.9 - 10.1 div	_____
Risetime	⩽3 usec	_____
MAGNIFIER		
X1	9.5 - 10.5 div	_____
X5	9.5 - 10.5 div	_____
X10	9.5 - 10.5 div	_____
BANDWIDTH		
X1		
50 kHz	Set to 10 div	
5 MHz	⩾7.1 div	_____
X5		
50 kHz	Set to 10 div	
5 MHz	⩾7.1 div	_____
X10		
50 kHz	Set to 10 div	
5 MHz	⩾7.1 div	_____
BEAM FINDER	Intensified beam on-screen	_____

5-16. ADJUSTMENT PROCEDURE.

5-17. The following paragraphs outline the procedure for accomplishing the adjustments required for the Model 180C/D. Use the equipment recommended in Table 5-1 or similar equipment having at least equivalent capability. Use only a nonmetallic adjustment tool.

5-18. The adjustment procedures should be performed in the sequence listed since some adjustments are dependent on control settings and results of previous steps. The adjustments may be accomplished individually, if desired, by referring to the preliminary control settings and the steps before the desired procedure.

5-19. COVER REMOVAL.

5-20. Model 180C. To gain access to the adjustments, the top covers and the rear LVPS access panel must be removed. Use a Posidrive type screwdriver for removing cover screws. See Figure 5-4. Remove the covers as follows:

a. Ensure that LINE power switch is OFF and disconnect power plug from ac line source.

b. Remove four screws holding top cover from each side of instrument.

c. Remove top cover by opening bottom end and pulling away from instrument.

d. Remove rear access cover by releasing single quarter-turn fastener.

5-21. Model 180D. To gain access to the rack-type instrument, the top cover, side cover and the rear LVPS access panel must be removed. See Figure 5-4. Remove the covers as follows:

a. Ensure that LINE power switch is OFF and disconnect power plug from ac line source.

b. Remove top cover, which is held in place with 8 screws.

c. Remove left side cover, held in place with 6 screws.

d. Remove rear access cover by releasing single quarter-turn fastener.

5-22. PRELIMINARY SETUP.

5-23. Install vertical and time base plug-ins in Model 180C/D. Set line voltage SELECTOR switch to desired power line operating voltage, 115V or 230V. Be sure that line fuse of correct value is installed. Connect instrument to line power source and apply power by turning LINE power switch ON. Allow 15 minutes for warm up. Check that Phase/Bandwidth switch is in Bandwidth position.

5-24. Some adjustment locations are identified in photographs at the end of this section. The page may be folded out for easy reference while performing the adjustment. Other adjustment locations are identified next to the procedure.

5-25. There are several adjustments which directly affect the final accuracy of the horizontal sweep. These must be made accurately and to the test limits specified to ensure that sweep accuracy will be maintained as time base plug-ins are interchanged. The adjustments given for the Low Voltage Power Supply, High Voltage Power

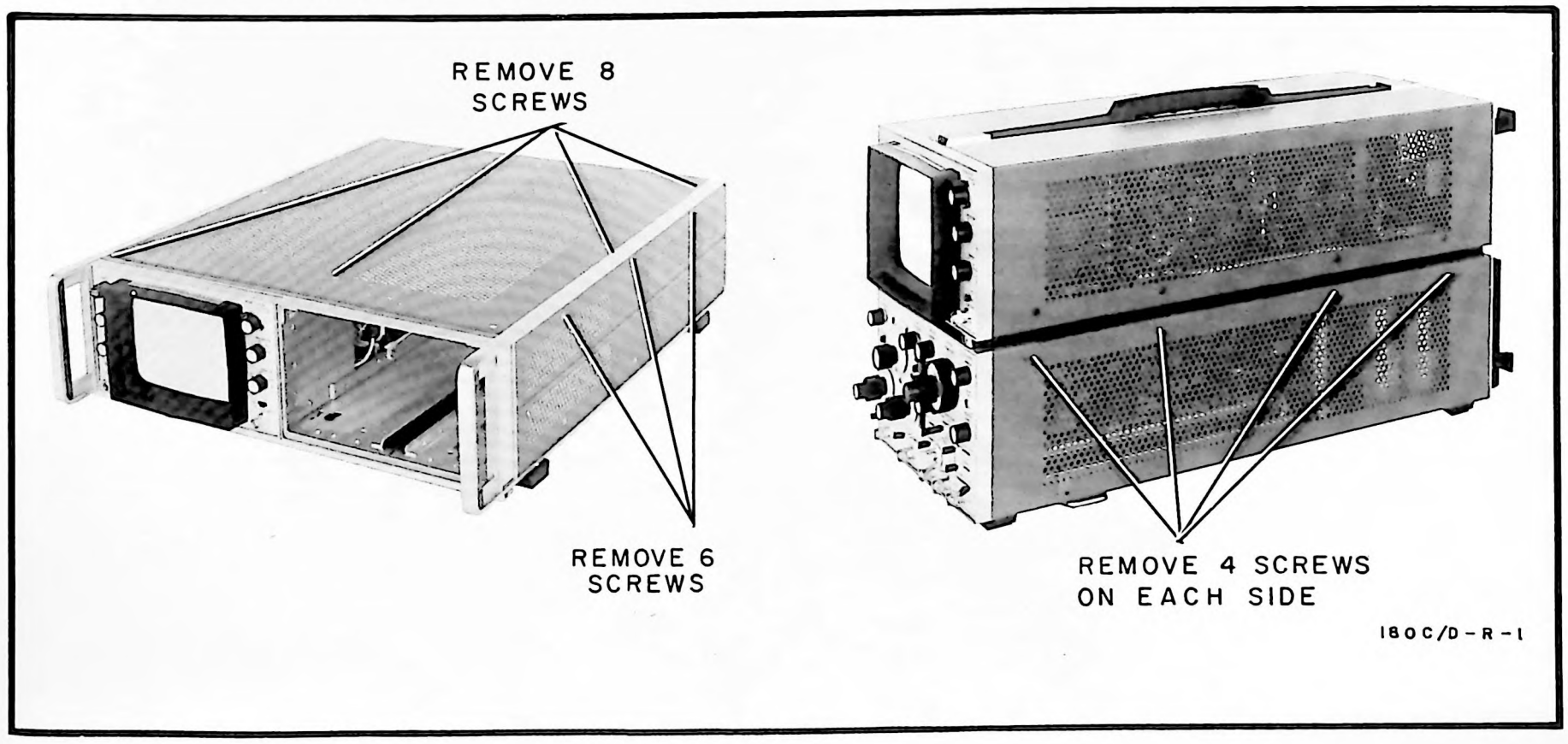


Figure 5-4. Cover Removal

Supply, and Horizontal Amplifier are particularly important in this respect.

5-26. LOW VOLTAGE POWER SUPPLY ADJUSTMENT.

a. Connect Digital Voltmeter to +100V test point A1A2TP1 (Figure 5-5).

b. Set +100V adjust A1A2R11 to obtain reading of +100 ±0.1V.

c. Connect Digital Voltmeter to +15V test point A1A2TP2.

d. Set +15V adjust A1A2R20 to obtain reading of +15V ±0.1V.

e. Connect Digital Voltmeter to −12.6V test point A1A2TP3.

f. Set −12.6V adjust A1A2R29 to obtain reading of −12.6V ±0.1V.

g. Connect Digital Voltmeter to −100V test point A1A2TP4.

h. Set −100V adjust A1A2R40 to obtain reading of −100V ±0.1V.

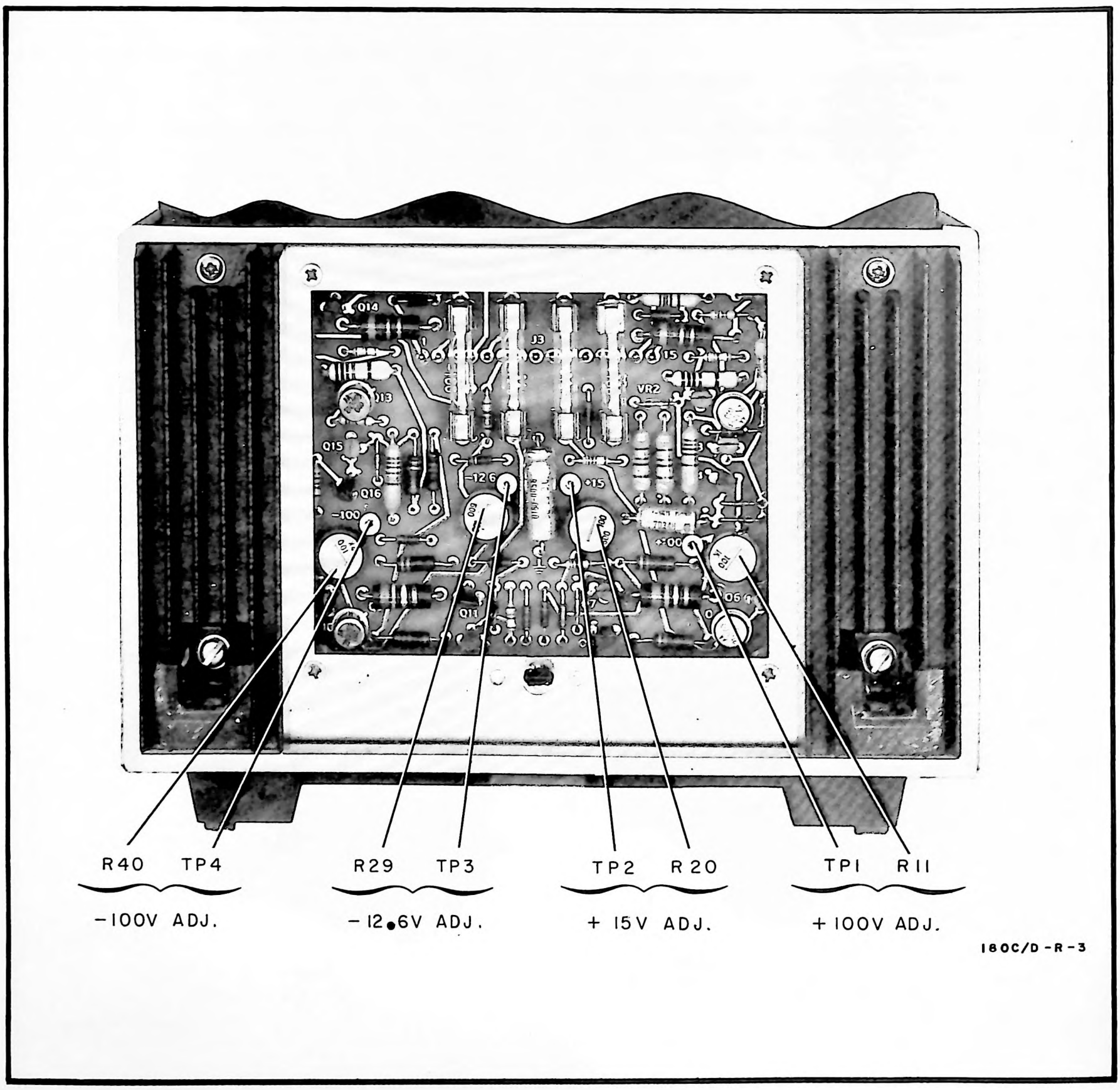


Figure 5-5. Low Voltage Power Supply Adjustments

5-27. HIGH VOLTAGE POWER SUPPLY ADJUSTMENT.

a. The required high voltage output of the supply is −3150V ±0.5%.

b. Using 1000:1 Divider Probe, monitor voltage at −100V test point A1A2TP4 with Digital Voltmeter (Figure 5-6).

c. Note voltage reading which will be approximately −0.100V. Accuracy in noting the voltage is essential for proper adjustment.

d. Multiply the reading obtained in step c by 31.50.

WARNING

This voltage is dangerous to life.

e. Using 1000:1 Divider Probe, monitor high voltage at −3150V Test Point A3TP1 with Digital Voltmeter (Figure 5-7).

f. Set High Voltage Adj A3R49 to obtain a reading exactly equivalent to the result obtained in step d (approximately −3.150V).

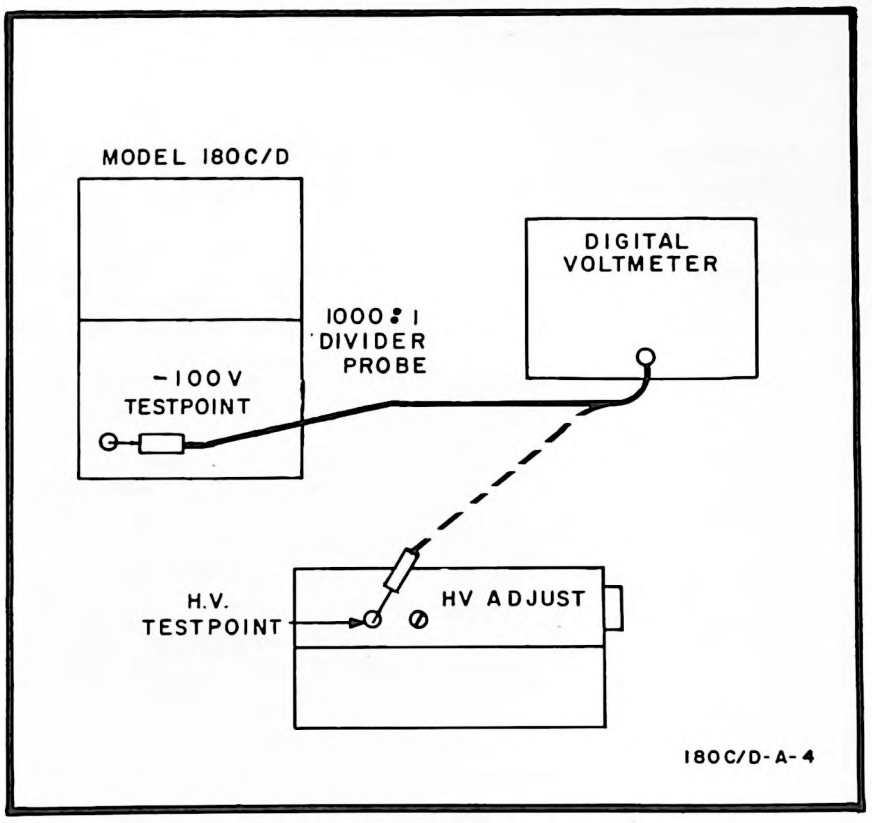


Figure 5-6. High Voltage Adjustment

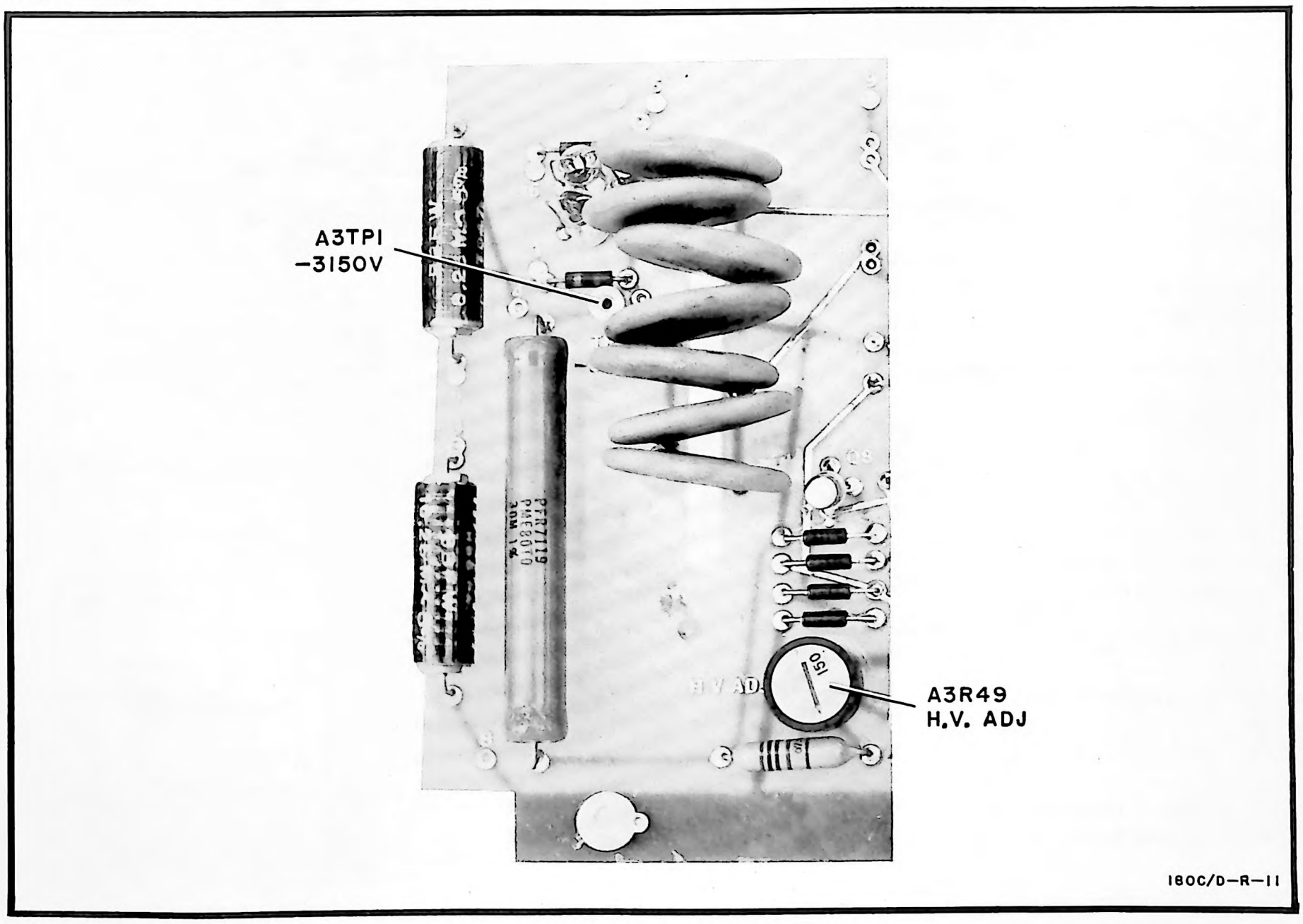


Figure 5-7. High Voltage Adjustment Location

5-28. ASTIGMATISM ADJUSTMENT.

a. Set DISPLAY to EXT.

b. Center low intensity spot with HORIZONTAL and Vertical POSITION controls.

c. Adjust FOCUS and ASTIGMATISM front-panel screwdriver adjustment for smallest round spot (Figure 5-8).

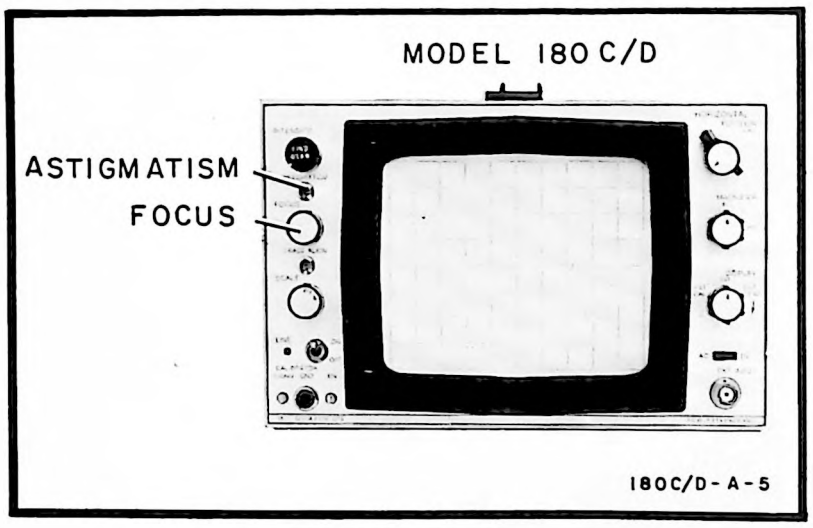


Figure 5-8. Astigmatism Adjustment

5-29. INTENSITY LIMIT ADJUSTMENT.

a. Set DISPLAY to EXT.

b. Center spot with HORIZONTAL and Vertical POSITION controls.

c. Set INTENSITY control to center (12 o'clock) position.

d. Adjust Intensity Limit Adj. A5R2 to just extinguish spot.

5-30. FLOOD GUN ADJUSTMENT.

a. Set INTENSITY fully ccw.

b. Set SCALE fully ccw.

c. Adjust Flood Pattern Adj A3R60 for uniform illumination intensity when SCALE control is varied throughout its full range (Figure 5-9).

5-31. TRACE ALIGNMENT ADJUSTMENT.

a. Set MAGNIFIER to X1.

b. Set Coupling to AC.

c. Connect Oscillator 400-Hz, 10V output to EXT INPUT (Figure 5-10).

d. Position trace on center horizontal graticule line.

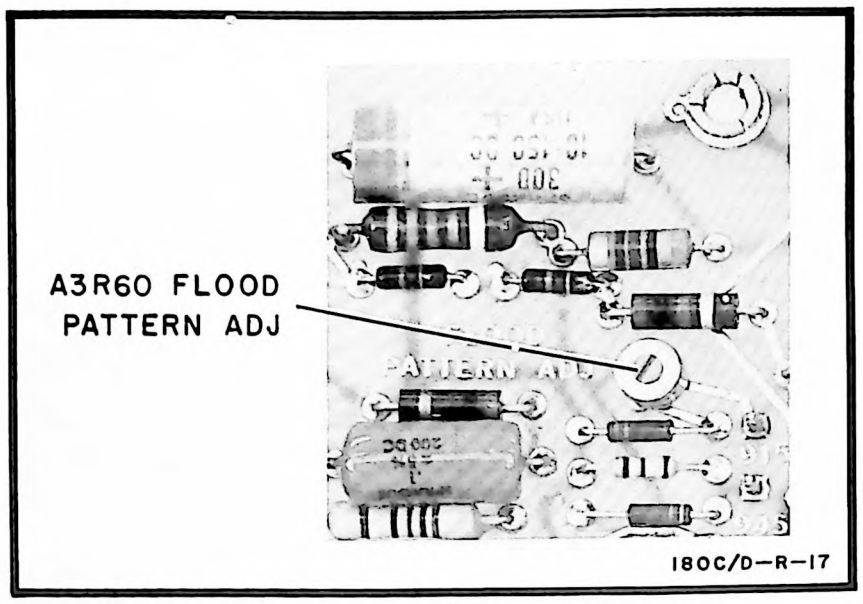


Figure 5-9. Flood Gun Adjustment Location

e. Set INTENSITY and FOCUS to view sharply defined trace.

f. Adjust TRACE ALIGN front-panel screwdriver adjustment R6 to align trace parallel to horizontal graticule line.

g. Connect Oscillator 400-Hz, 10V output to vertical plug-in.

h. Set vertical plug-in controls to obtain a vertical trace

i. Adjust Y ALIGN adj A2R57 to align vertical trace parallel to vertical graticule line (Figure 5-11).

j. Recheck trace alignment. Repeat adjustment procedure if necessary to ensure that exact X and Y alignment is obtained.

Note

Exact adjustment is very important if repeatable risetimes are to be obtained in both +UP and –UP operation.

k. Disconnect Oscillator.

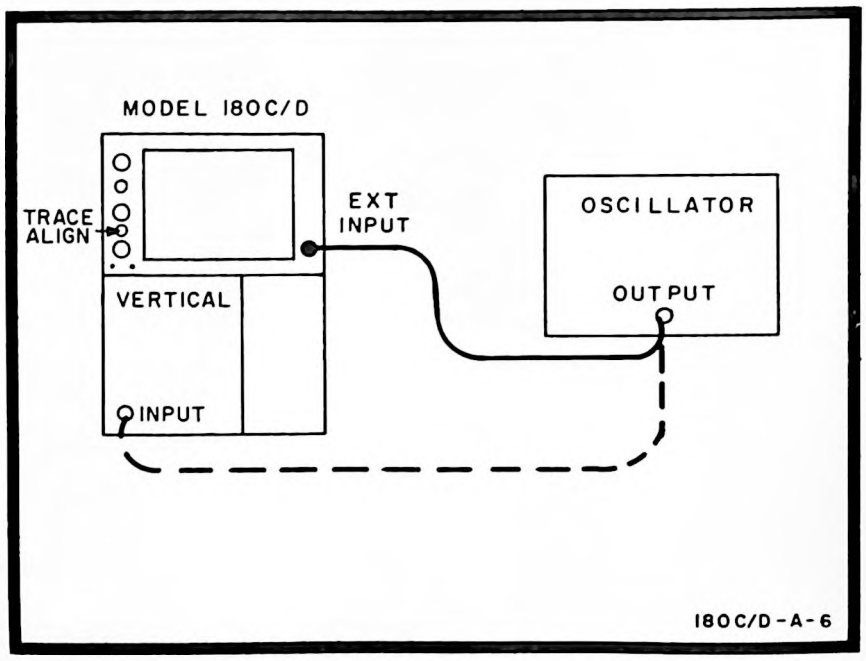


Figure 5-10. Trace Alignment Adjustment

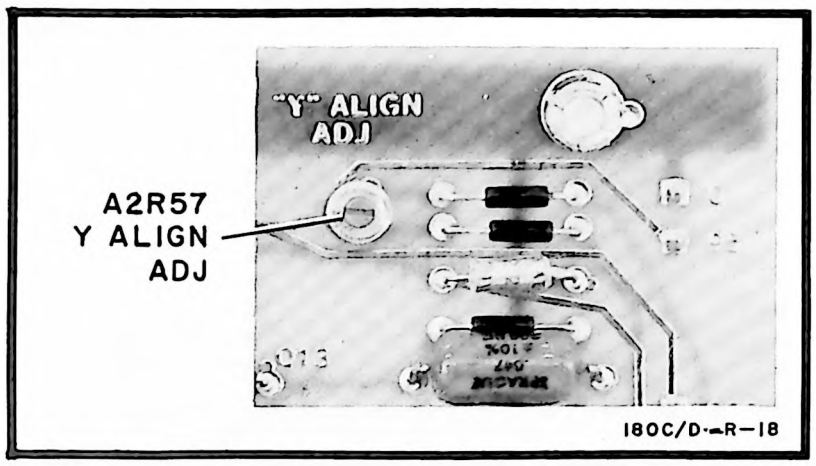


Figure 5-11. Y Alignment Adjustment Location

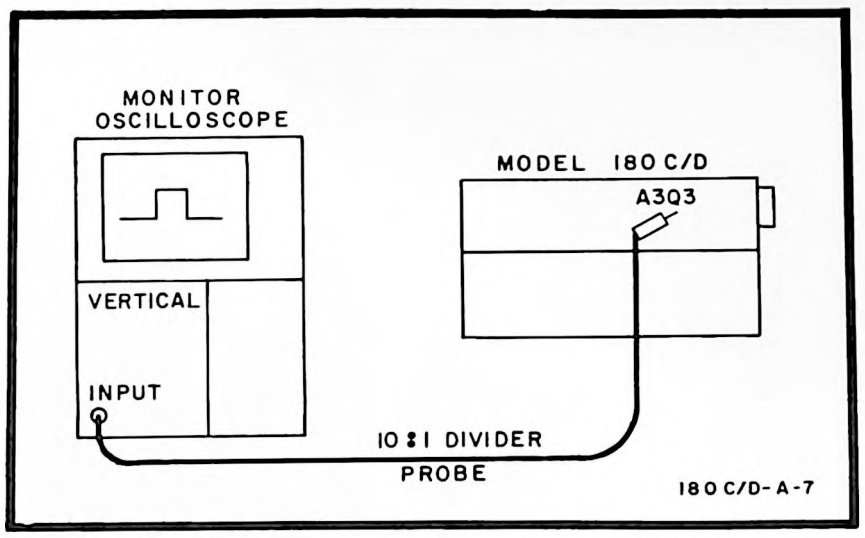


Figure 5-12. Gate Amplifier Response Adjustment

5-32. GATE AMPLIFIER RESPONSE ADJUSTMENT.

a. Set the following controls as applicable:

HORIZONTAL DISPLAY	INT
Main Time/Div	0.1 usec
Main Vernier	CAL
Sweep Mode	AUTO
Sweep Display	MAIN
Delayed Time/Div	OFF

b. Set Monitor Oscilloscope controls as follows:

Volts/Div	1
Time/Div	0.1 usec
Trigger Source	INT
Slope	+
Coupling	DC

c. Using 10:1 Divider Probe and Monitor Oscilloscope, observe signal at collector of A3Q3, (Figure 5-12 and Figure 5-13).

d. Rotate INTENSITY control cw until gate pulse amplitude is 60V.

e. Adjust Gate Resp Adj No. 1 and No. 2 for optimum fast risetime and pulse flat-top response. Decreasing capacitance of No. 1 reduces risetime; decreasing capacitance of No. 2 reduces overshoot.

f. Disconnect Monitor Oscilloscope.

5-33. DC BALANCE ADJUSTMENT.

a. Set MAGNIFIER to X10.

b. Set HORIZONTAL DISPLAY to EXT CAL.

c. Center spot with HORIZONTAL POSITION control.

d. Set MAGNIFIER to X1.

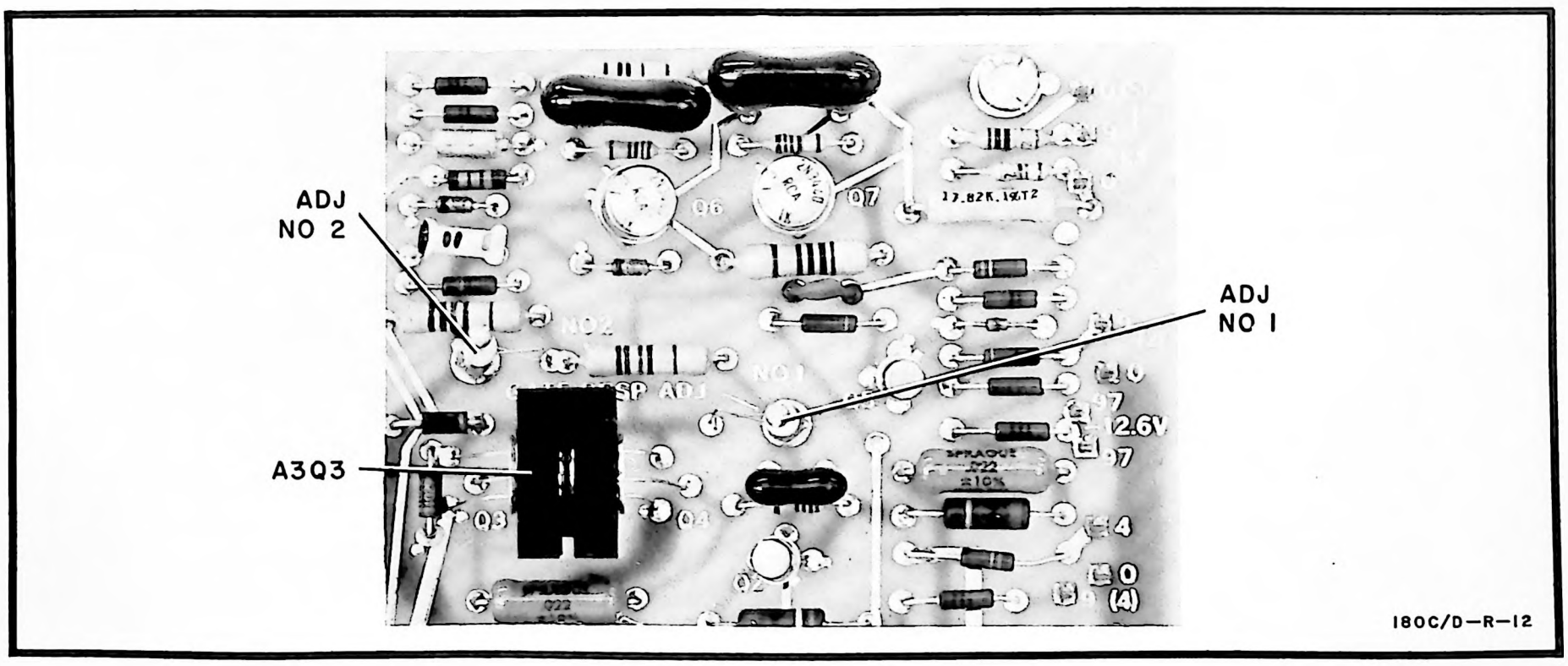


Figure 5-13. Gate Amplifier Adjustment Location

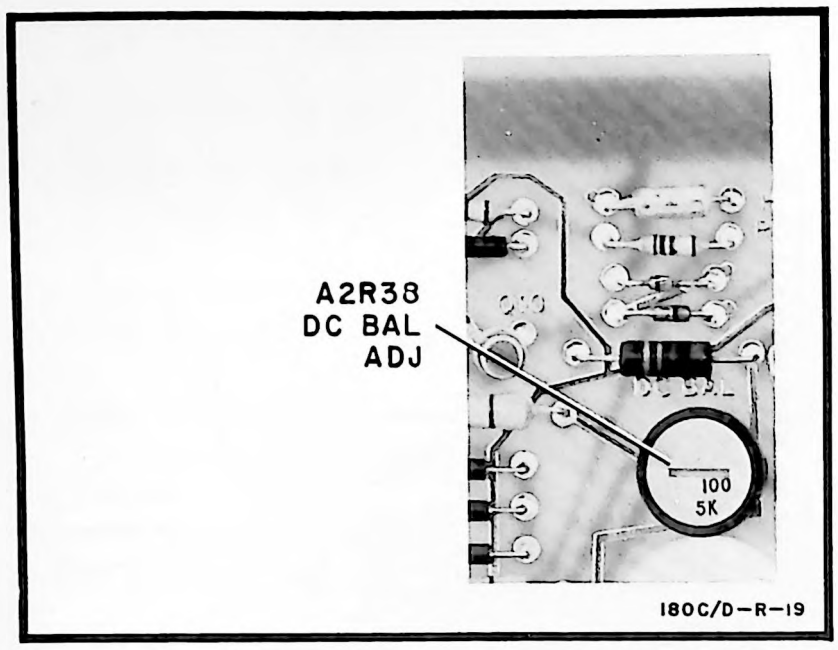


Figure 5-14. DC Balance Adjustment Location

e. Adjust DC Bal adj A2R38 to recenter spot (Figure 5-14).

f. Repeat steps a through e until spot does not shift from center while switching MAGNIFIER from X1 to X10.

5-34. VERNIER BALANCE ADJUSTMENT.

a. Set MAGNIFIER to X1.

b. Rotate HORIZONTAL DISPLAY to approximately 2 o'clock position, but not to INT detent.

c. Center spot with HORIZONTAL POSITION control.

d. Rotate HORIZONTAL DISPLAY to EXT CAL.

e. Adjust Vern Bal adj A2R14 to recenter spot (Figure 5-15).

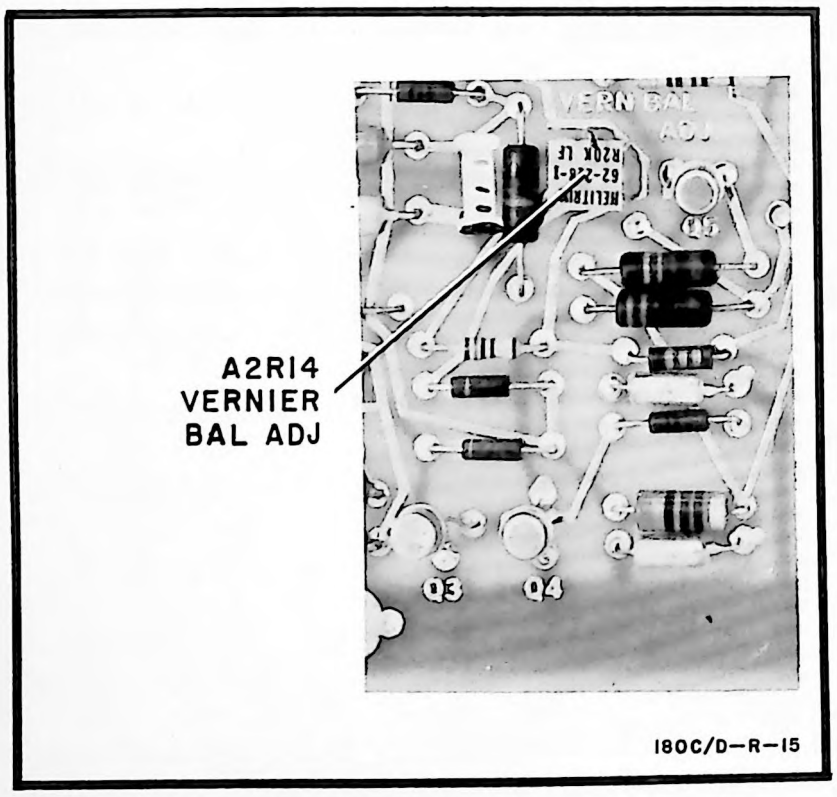


Figure 5-15. Vernier Balance Adjustment Location

f. Repeat steps b through e until spot does not shift from center when HORIZONTAL DISPLAY is rotated from fully ccw (not in INT) to EXT CAL.

5-35. HORIZONTAL GAIN ADJUSTMENT.

Note

This adjustment is critical if Time Base interchangeability is desired without recalibration. Critical adjustment is achieved by injecting a precise current into the emitter-base junction of A2Q3 and adjusting for the specified deflection. An alternate method not requiring use of HP Model 10411A Horizontal Gain Calibrator is provided.

a. Set controls as follows:

HORIZONTAL DISPLAY EXT CAL
MAGNIFIER X1

b. Check +100-volt supply for +100V ±0.1V.

Note

The calibrating accuracy of the Model 10411A Horizontal Gain Calibrator used for this adjustment procedure is determined by the accuracy of the +100V supply. If the power supply is not +100V ±0.1V, the gain adjustment will be out of tolerance.

c. Connect Horizontal Gain Calibrator as follows:

1. Black lead: connect to chassis (power supply ground).

2. Yellow lead: connect to emitter of A2Q3.

3. Red lead: connect to +100-volt supply input to Horizontal Amplifier (+100V square-pin connections are white-red (92) wires).

d. Set Horizontal Gain Calibrator magnifier switch to X1.

e. A bright spot should be visible near each side of the display. Adjust HORIZONTAL POSITION to center left-hand spot exactly on left-hand (first) vertical graticule line.

f. Set INTENSITY and FOCUS to obtain low intensity, sharply focused spots.

g. Adjust X1 Gain Adj A2R36 for exactly 10 divisions of separation between spots (Figure 5-16 and Figure 5-17).

h. Set MAGNIFIER to X5 and Horizontal Gain Calibrator magnifier switch to X5.

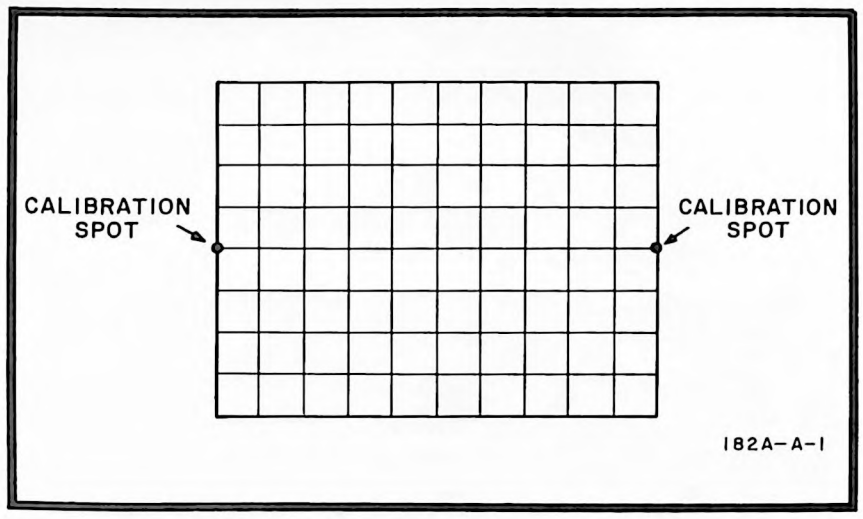


Figure 5-16. Calibration Display

i. Adjust X5 Gain Adj A2R34 for exactly 10 divisions of separation between spots.

j. Set MAGNIFIER to X10 and Horizontal Gain Calibrator magnifier switch to X10.

k. Adjust X10 Gain Adj A2R32 for exactly 10 divisions of separation between spots.

l. Disconnect Horizontal Gain Calibrator.

5-36. HORIZONTAL GAIN ADJUSTMENT (ALTERNATE PROCEDURE).

a. Set controls as follows:

HORIZONTAL DISPLAY EXT CAL
HORIZONTAL MAGNIFIER X1

b. Check +100V supply for +100V ±0.1V.

WARNING

+100V is present at open lead of resistor.

c. Connect 40-kilohm, 0.1%, 1/2W resistor between +100V supply and emitter of A2Q3. Keep connection lead lengths short as possible to avoid stray pickup or oscillations. Do not leave resistor connected throughout adjustment as thermal rise will shift current reference.

d. Adjust HORIZONTAL POSITION to center left-hand spot exactly on left-hand vertical graticule line.

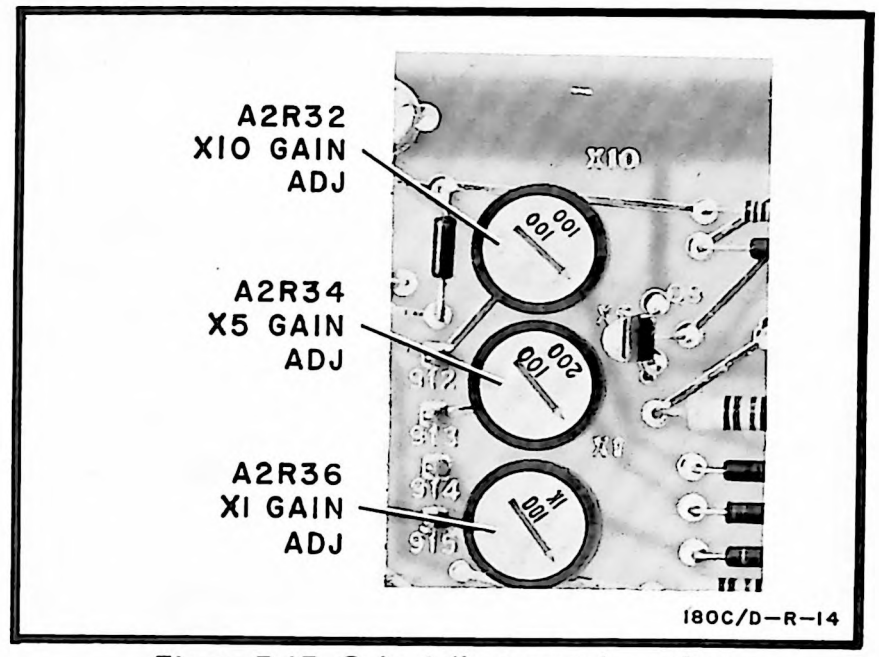


Figure 5-17. Gain Adjustment Location

e. While alternately connecting and disconnecting resistor to emitter of A2Q3, adjust X1 Gain Adj A2R36 for exactly 10 major divisions of separation between spot positions (Figure 5-16 and Figure 5-17).

f. Set HORIZONTAL DISPLAY to INT and time base for 1 ms/div sweep speed.

g. Apply 1-ms markers from Time Mark Generator to input of vertical plug-in.

h. Adjust Time Base 1-ms calibration adjustment to obtain display of eleven markers in 10 divisions. Second marker should be on 2nd graticule line and 10th marker on 10th graticule line.

i. Set HORIZONTAL MAGNIFIER to X5.

j. Adjust X5 Gain Adj A2R34 to obtain display of exactly 1 marker for 5 divisions.

k. Set HORIZONTAL MAGNIFIER to X10.

l. Adjust X10 Gain Adj A2R32 obtain display of exactly 1 marker for 10 divisions.

m. Disconnect Time Mark Generator.

5-37. PHASE ADJUSTMENT.

a. Set controls as follows:

Phase/Bandwidth Switch Phase
HORIZONTAL MAGNIFIER X1
HORIZONTAL DISPLAY EXT CAL

b. Connect 10-kHz sine wave output of Oscillator to HORIZONTAL EXT INPUT and to vertical plug-in Channel B input (Figure 5-18).

Note

Channel B of a multichannel vertical plug-in is normally used for phase measurement. If another channel must be used, connect Oscillator to that channel.

c. Adjust Oscillator output and vertical amplifier Volts/Div to obtain 8-division display.

d. Adjust Input Comp Adj A2C6 for display of single diagonal line (no phase shift). See Figure 5-19.

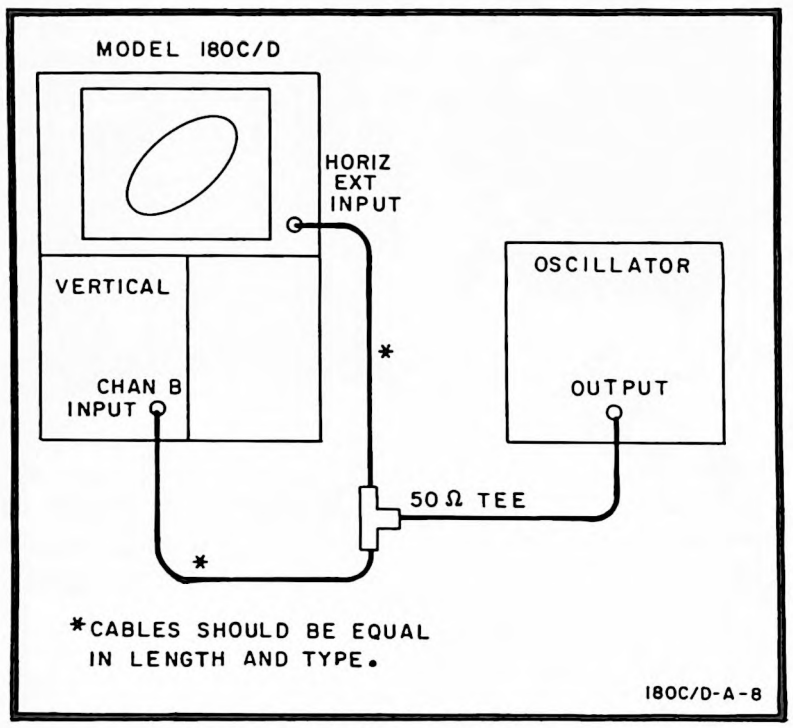


Figure 5-18. Phase Adjustment

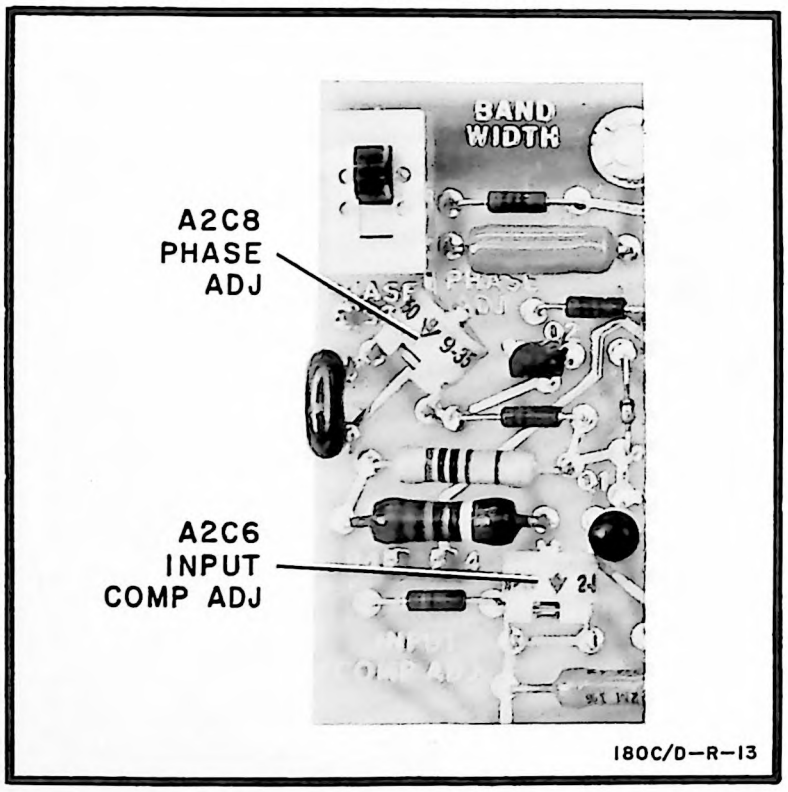


Figure 5-19. Phase and Input Adjustment Location

e. Set Oscillator for output of 100-kHz sine wave.

f. Adjust Phase Adj A2C8 for display of single diagonal line (no phase shift).

g. Repeat steps b through f until no phase shift occurs for either frequency.

h. Disconnect Oscillator.

i. Return Phase/Bandwidth switch to Bandwidth position.

5-38. TRANSIENT RESPONSE ADJUSTMENT.

Note

Omit this adjustment procedure for normal calibration and perform the Horizontal Linearity Adjustment. This procedure should only be used if major repairs or complete module replacement has been made.

a. Set HORIZONTAL DISPLAY to EXT CAL.

b. Connect 1V p-p square wave at 200-kHz repetition rate from Square Wave Generator to HORIZONTAL EXT INPUT and to Monitor Oscilloscope vertical input (Figure 5-20).

c. Set Monitor Oscilloscope time base to operate at sweep of 1 usec/div and synchronize Monitor Oscilloscope with 200-kHz signal.

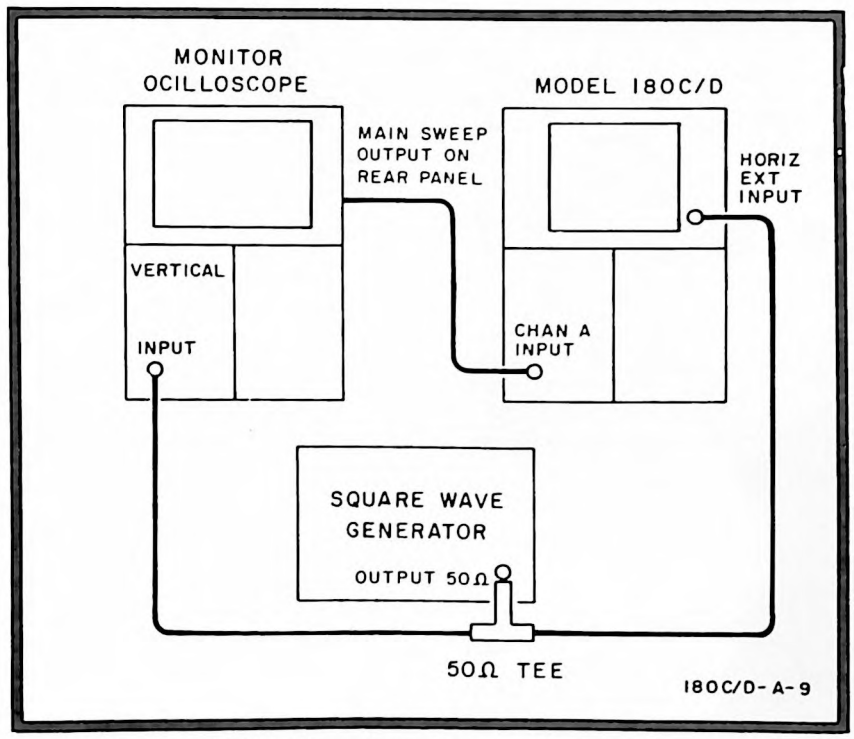


Figure 5-20. Transient Response Adjustment

d. Connect 1 usec/div sweep signal from Monitor Oscilloscope rear-panel Main Sweep Output to Channel A input of Model 180C/D.

e. Adjust Vertical plug-in VOLTS/DIV and Vernier controls to obtain 8-division display.

f. Observe displayed waveform. At this stage of adjustment, waveform will typically exhibit 5% (approximately 0.5 div) overshoot. If overshoot is greater, adjust HF Adj No. 1 A2C12, HF Adj No. 2 A2C21, and HF Adj No. 3 A2C20 to obtain flat-top response with approximately 5% overshoot on lower right-hand corner of displayed pulse.

Note

Capacitors for HF Adj No. 1 and HF Adj No. 3 should be adjusted so their slugs are almost equally extended.

g. Disconnect Monitor Oscilloscope.

5-39. HORIZONTAL LINEARITY ADJUSTMENT.

Note

Ensure that time base plug-in has been properly calibrated before proceeding with this adjustment.

a. Set HORIZONTAL DISPLAY to INT.

b. Connect 4V p-p 50-MHz sine wave output from Constant Amplitude Signal Generator to vertical plug-in Channel A input (Figure 5-21).

c. Set HORIZONTAL MAGNIFIER to X10.

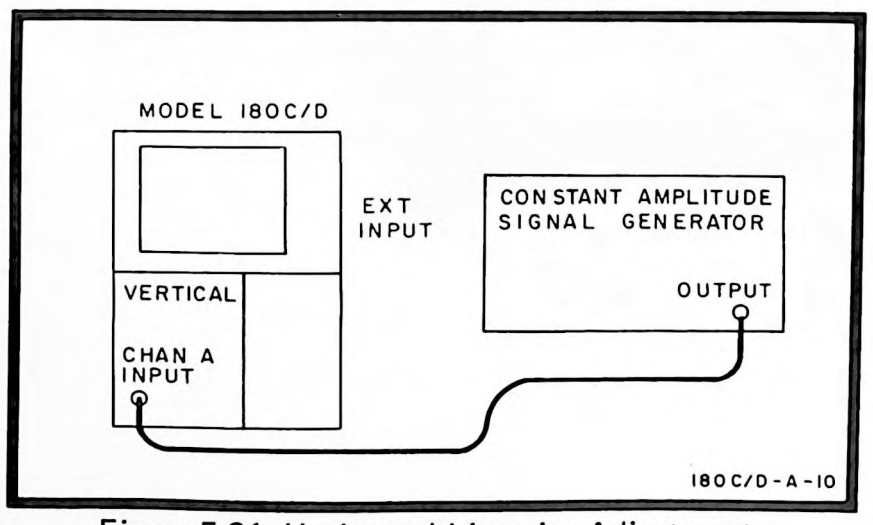


Figure 5-21. Horizontal Linearity Adjustment

d. Select fastest sweep speed (.05 or .1 usec/div) and obtain display.

e. Adjust HF Adjust No. 1, No. 2 and No. 3 for best overall linearity of center 80 divisions of available display. Use HORIZONTAL POSITION control to permit viewing right, center and left portions of display. HF Adj No. 1 affects left portion, HF Adj No. 2 center portion and HF Adj No. 3 right portion of sweep. (See Figure 5-22.)

f. Disconnect Constant Amplitude Signal Generator.

5-40. This completes the adjustment procedure. If desired, the instrument performance may be tested to Model 180C/D specifications using the Performance Check procedure. If satisfactory adjustment or instrument performance is not obtained, refer to Section VIII of this manual for troubleshooting information.

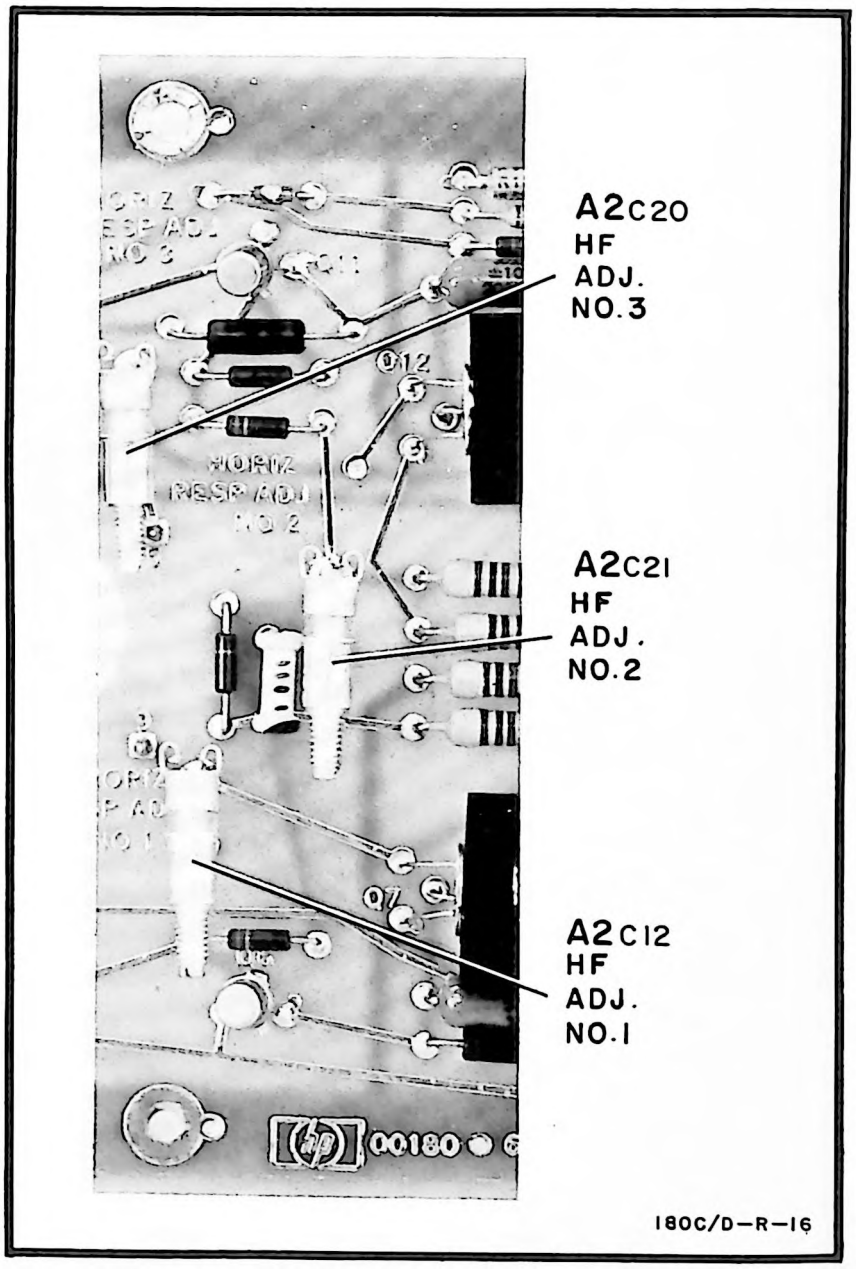
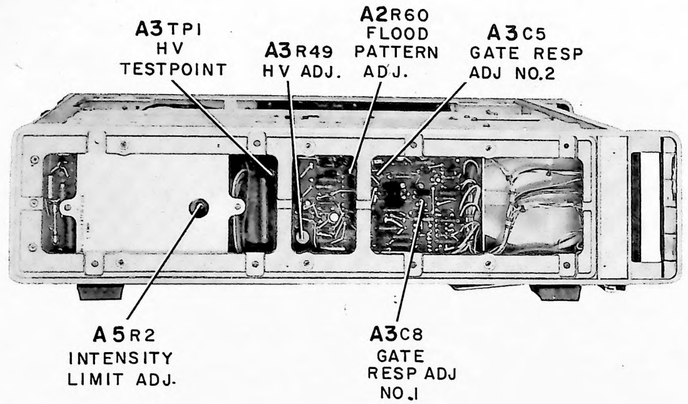
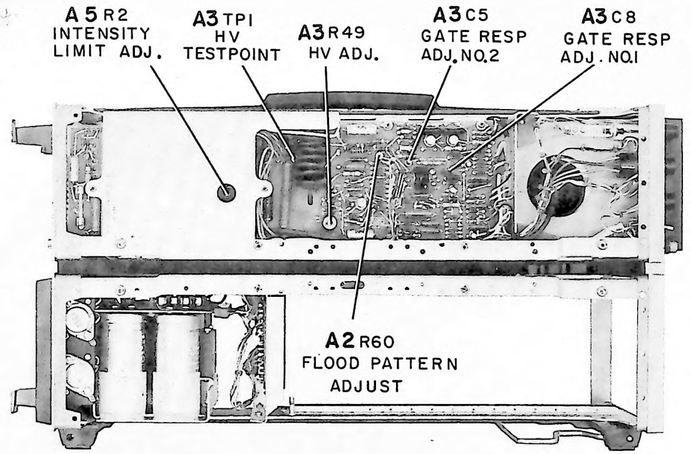
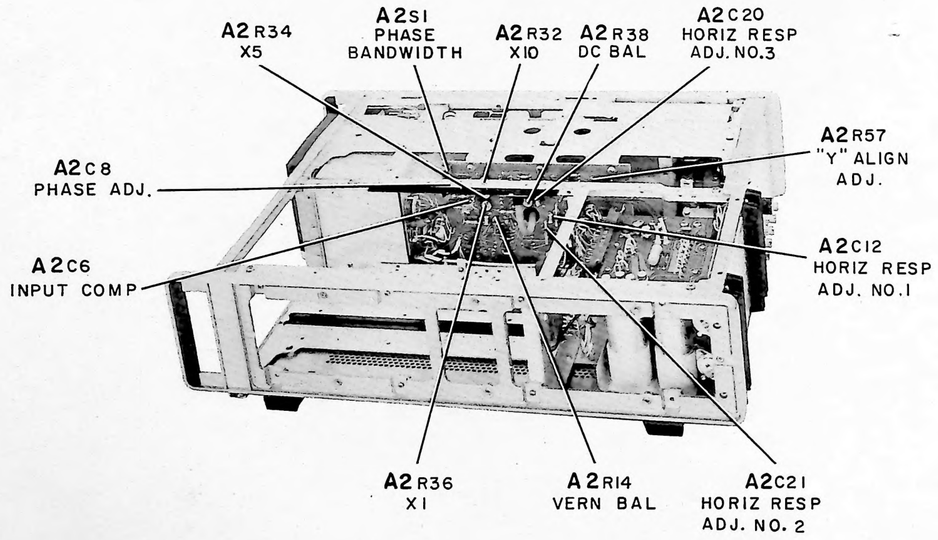
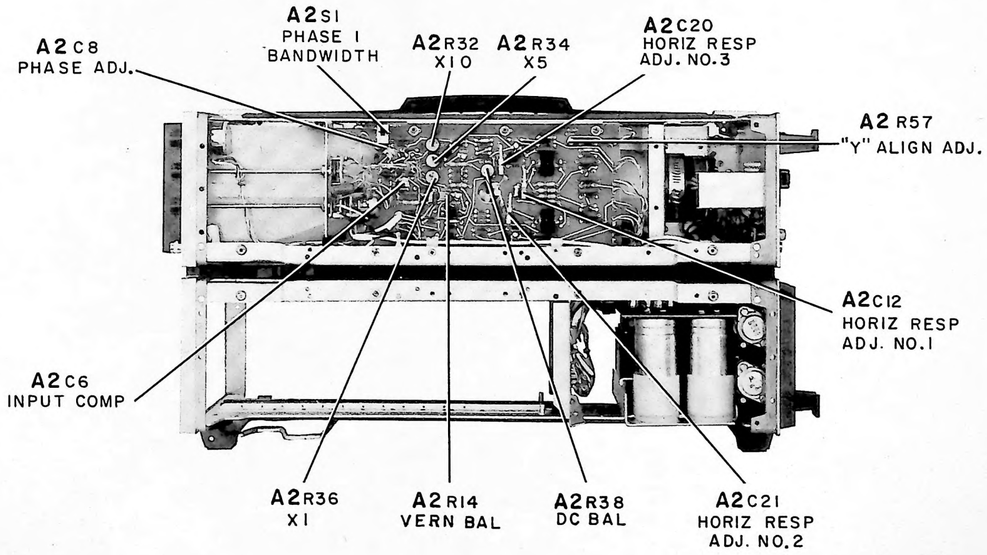


Figure 5-22. Linearity Adjustment Location









180C/D-R-6

Figure 5-23. Adjustment Locations

ANUAL

OPE
0C/D



PACKARD

HP 180C/D

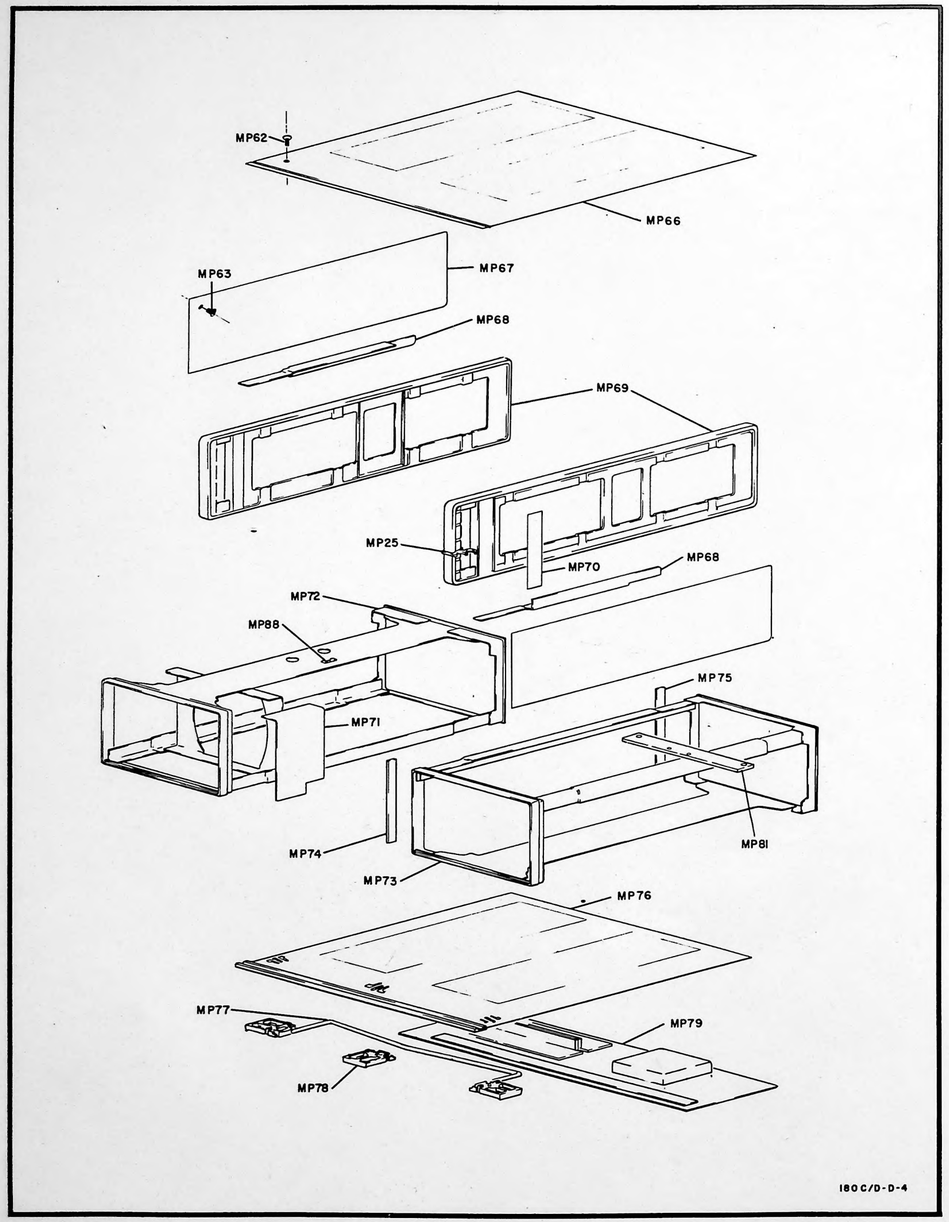
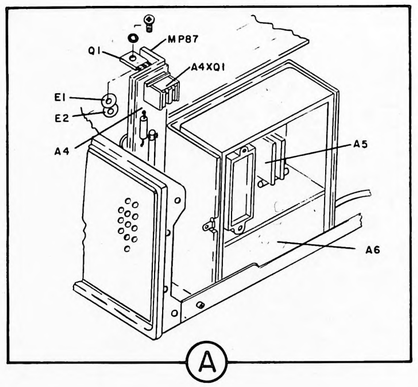
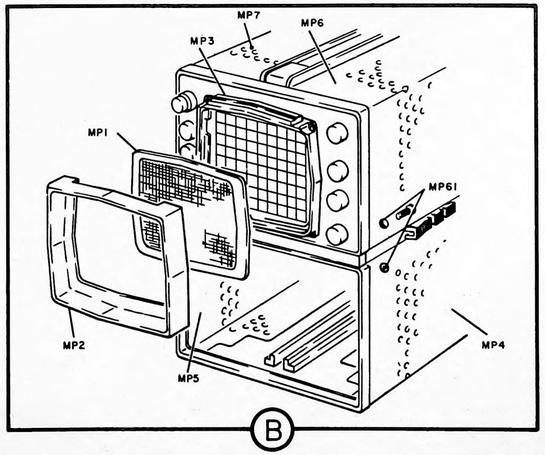
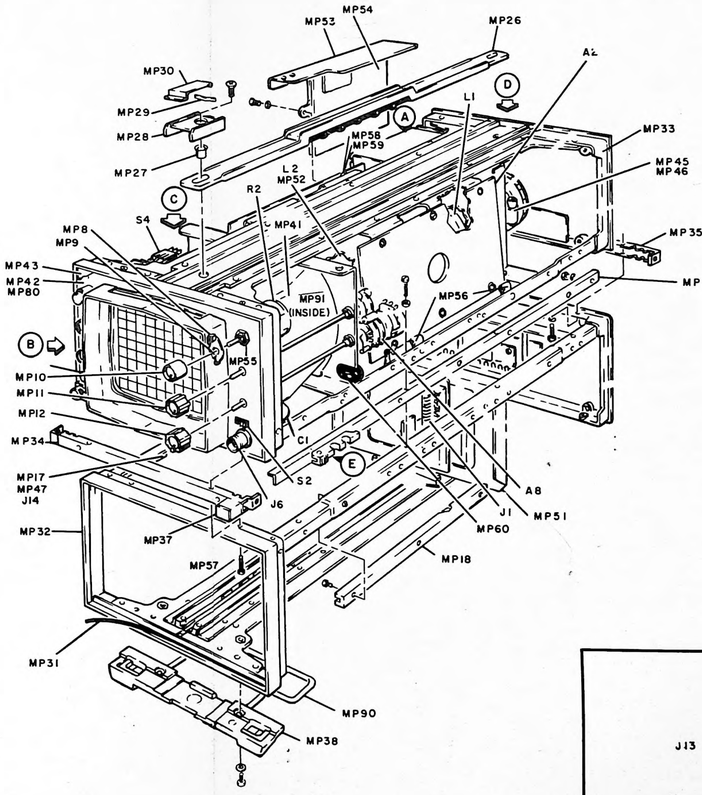
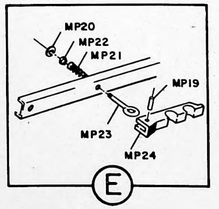


Figure 6-1. Model 180D Mechanical Parts









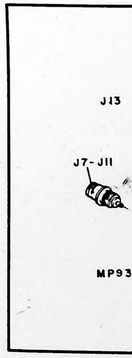


Figure 6-

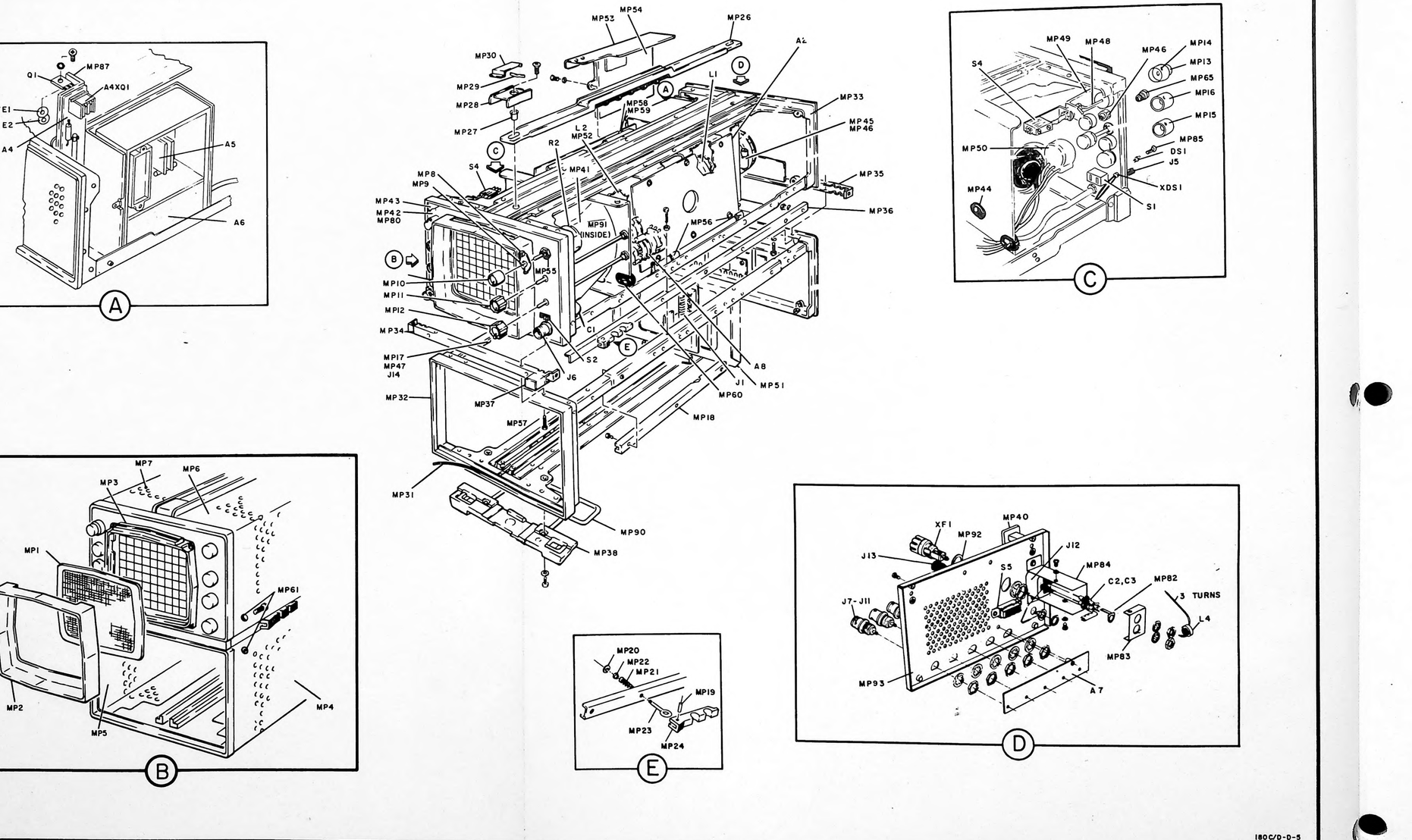
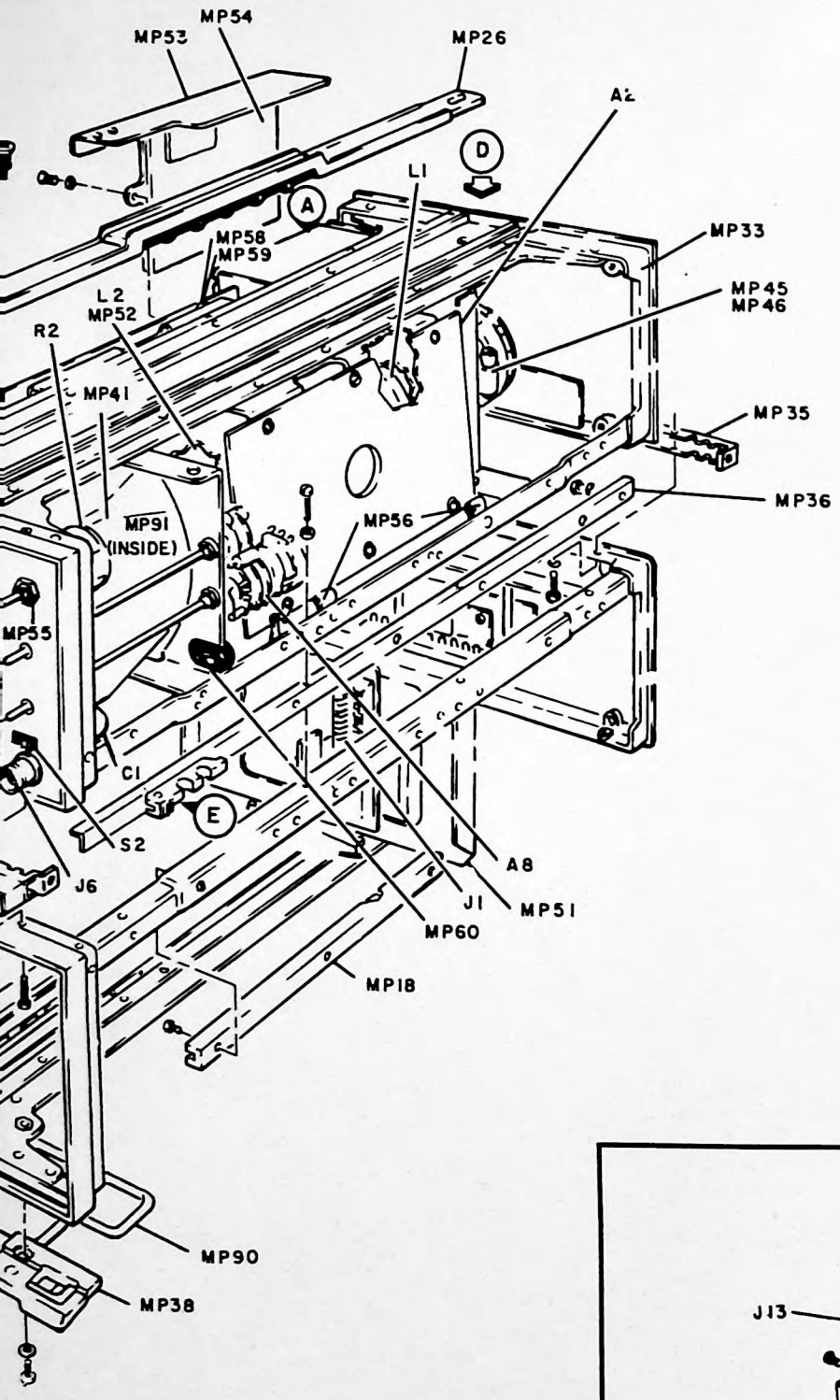
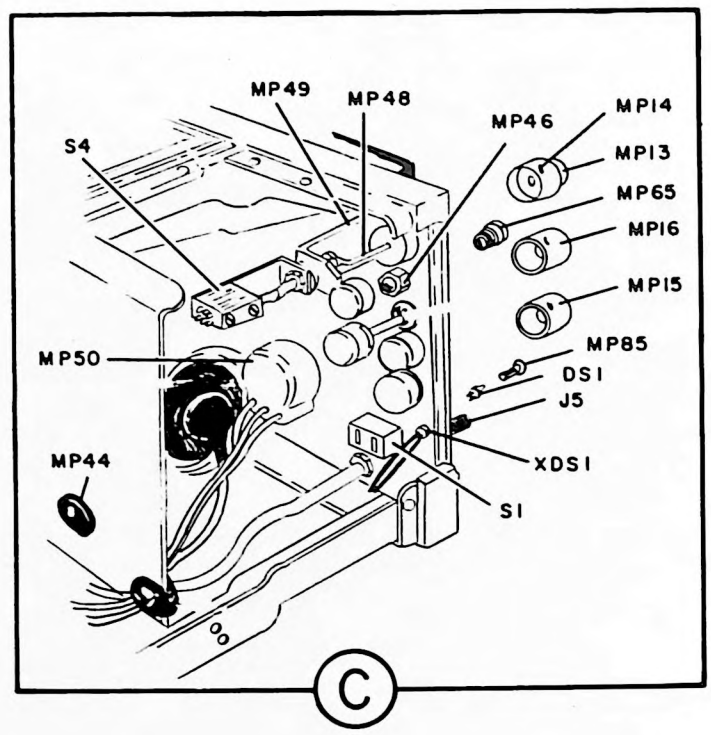
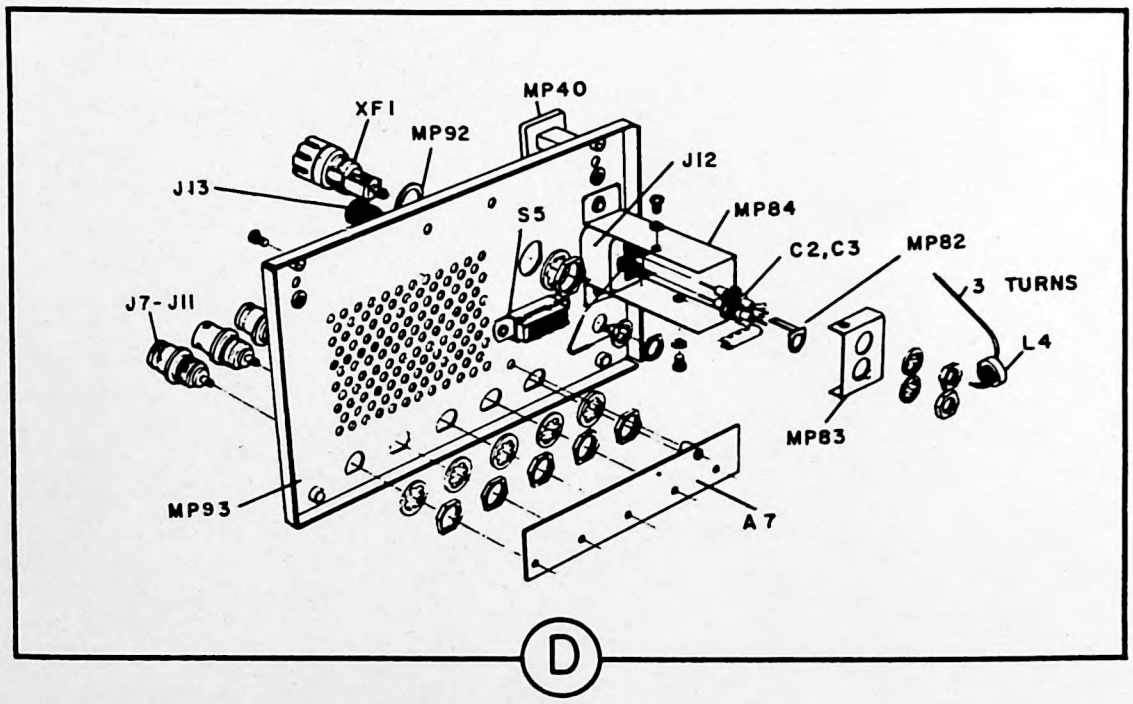
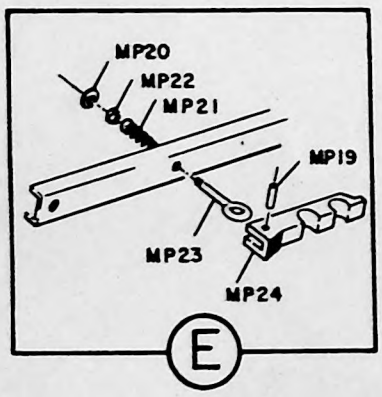


Figure 6-2. Model 180C/D Mechanical Parts









180C/D-D-5

Figure 6-2. Model 180C/D Mechanical Parts

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. The abbreviations used in the parts list are described in Table 6-1. Table 6-2 lists the parts in alphanumeric order by reference designator and includes the manufacturer and manufacturer's part number. Table 6-3 contains the list of manufacturer's codes.

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts from Hewlett-Packard, address order or inquiry to the nearest Hewlett-Packard Sales/Service Office and supply the following information:

a. Instrument model and serial number.

b. HP Part Number of item(s).

c. Quantity of part(s) desired.

d. Reference designator of part(s).

6-5. To order a part not listed in the table, provide the following information:

a. Instrument model and serial number.

b. Description of the part, including function and location in the instrument.

c. Quantity desired.

Table 6-1. Abbreviations for Replaceable Parts List

A = ampere(s)	GRD = ground(ed)	NPO = negative positive zero (zero temperature coefficient)	RWV = reverse working voltage				
ASSY = assembly	H = henry(ies)	NPN = negative-positive-negative	S-B = slow-blow				
BD = board(s)	HG = mercury	NSR = not separately replaceable	SCR = silicon controlled rectifier				
BH = binder head	HP = Hewlett-Packard	OBD = order by description	SE = selenium				
BP = bandpass	HZ = hertz	OH = oval head	SEC = second(s)				
C = centi (10^{-2})	IF = intermediate freq.	OX = oxide	SECT = section(s)				
CAR = carbon	IMPG = impregnated	P = peak	SI = silicon				
CCW = counterclockwise	INCD = incandescent	PC = printed (etched) circuit(s)	SIL = silver				
CER = ceramic	INCL = include(s)	PF = picofarads	SL = slide				
CMO = cabinet mount only	INS = insulation(ed)	PHL = Phillips	SP = single pole				
COAX = coaxial	INT = internal	PIV = peak inverse voltage(s)	SPL = special				
COEF = coefficient	K = kilo (10^{3})	PNP = positive-negative-positive	ST = single throw				
COMP = composition	KG = kilogram	P/O = part of	STD = standard				
CONN = connector(s)	LB = pound(s)	PORC = porcelain	TA = tantalum				
CRT = cathode-ray tube	LH = left hand	POS = position(s)	TD = time delay				
CW = clockwise	LIN = linear taper	POT = potentiometer(s)	TFL = teflon				
D = deci (10^{-1})	LOG = logarithmic taper	P-P = peak-to-peak	TGL = toggle				
DEPC = deposited carbon	LPF = low-pass filter(s)	PRGM = program	THYR = thyristor				
DP = double pole	LVR = lever	PS = polystyrene	TI = titanium				
DT = double throw	M = milli (10^{-3})	PWV = peak working voltage	TNLDIO = tunnel diode(s)				
ELECT = electrolytic	MEG = mega (10^{6})	RECT = rectifier(s)	TOL = tolerance				
ENCAP = encapsulated	MET FILM = metal film	RF = radio frequency	TRIM = trimmer				
EXT = external	MET OX = metal oxide	RFI = radio frequency interference	U = micro (10^{-6})				
F = farad(s)	MFR = manufacturer	RH = round head or right hand	V = volts				
FET = field-effect transistor(s)	MINAT = miniature	RMO = rack mount only	VAR = variable				
FH = flat head	MOM = momentary	RMS = root mean square	VDCW = dc working volt(s)				
FIL H = fillister head	MTG = mounting		W = watt(s)				
FXD = fixed	MY = mylar		W/ = with				
G = giga (10^{9})	N = nano (10^{-9})		WIV = working inverse voltage				
GE = germanium	N/C = normally closed		W/O = without				
GL = glass	NE = neon		WW = wirewound				
	N/O = normally open						

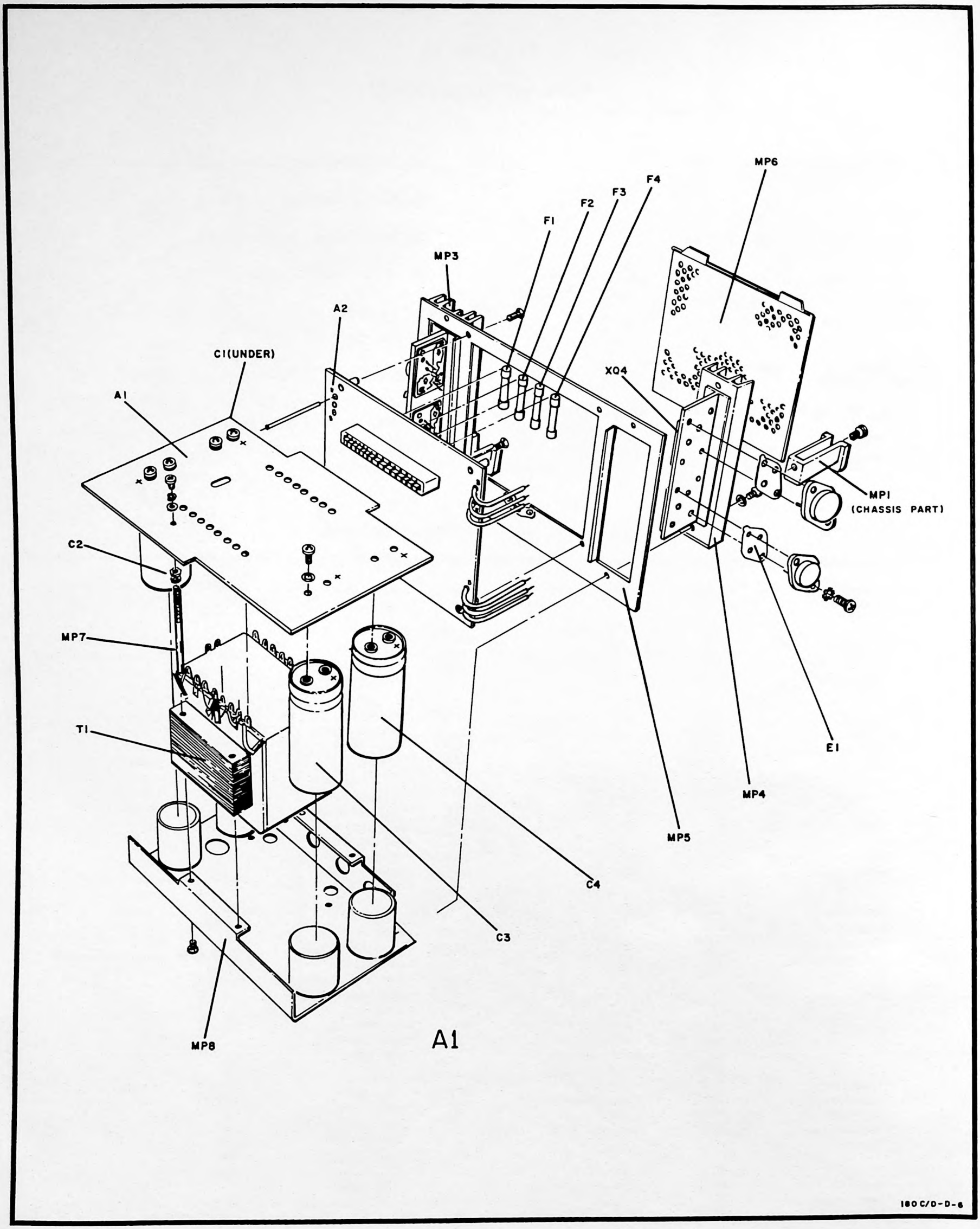


Figure 6-3. Low Voltage Power Module Exploded View

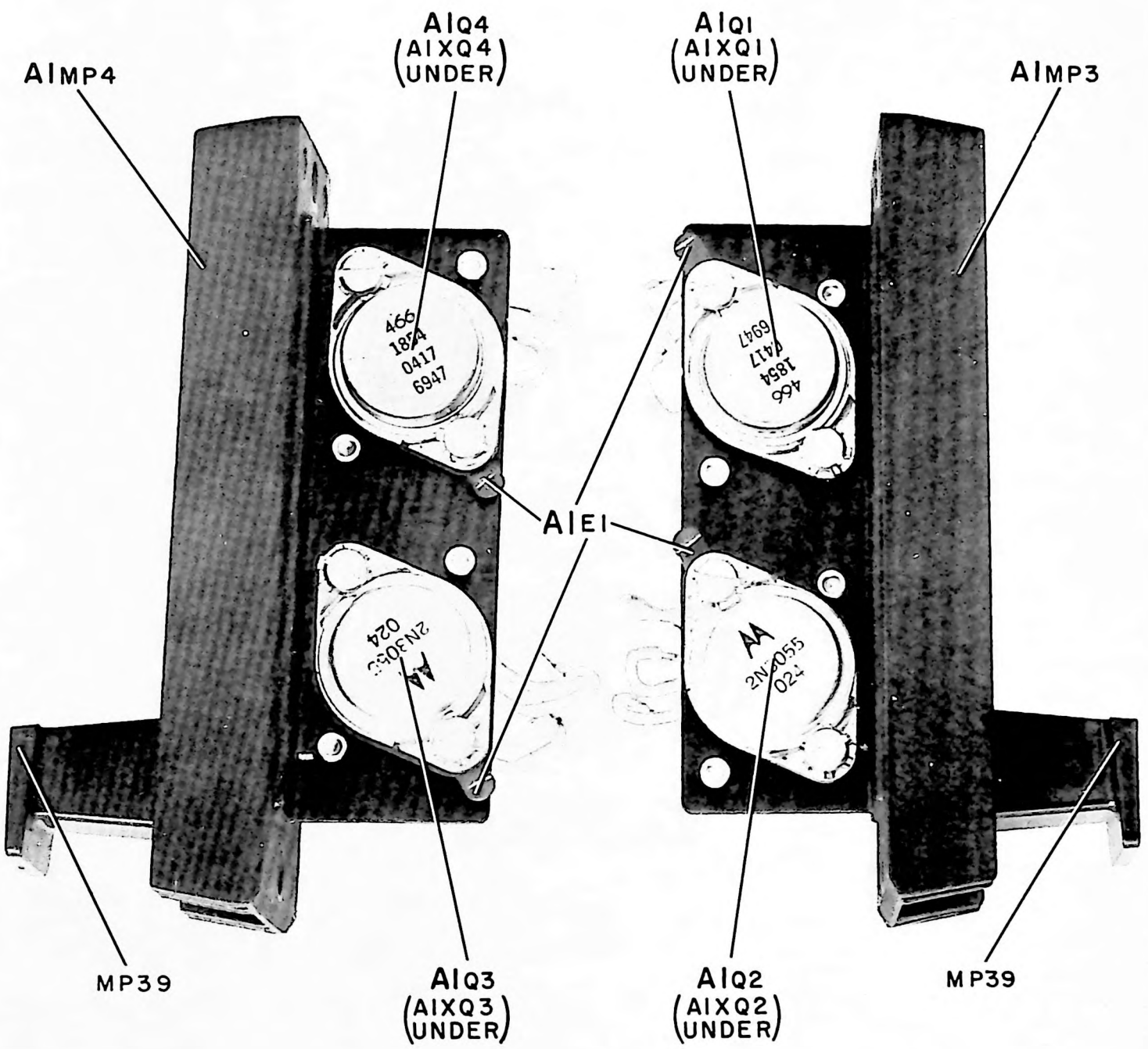


Figure 6-4. Series Regulator Parts Identification

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	00180-60001	1	POWER MODULE:LOW VOLTAGE	28480	00180-60001
A1C1	0180-1807	2	C:FXD ELECT 290 UF +50-10% 200VDCW	56289	32D291F200AB2A-DQB
A1C2	0180-1865	1	C:FXD ELECT 2100 UF +75-10% 40VDCW	56289	32D212G040AB2A-DQB
A1C3	0180-1809	1	C:FXD ELECT 3400 UF +75-10% 25VDCW	56289	32D342G025AB2A-DQB
A1C4	0180-1807		C:FXD ELECT 290 UF +50-10% 200VDCW	56289	32D291F200AB2A-DQB
A1E1	1200-0043	4	INSULATOR:TSTR MOUNTING(TO-3)	71785	293011
A1F1	2110-0065	2	FUSE:0.375A 250V	75915	312.375
A1F2	2110-0002	2	FUSE:CARTRIDGE 2 AMP 3 AG	75915	312.002
A1F3	2110-0002		FUSE:CARTRIDGE 2 AMP 3 AG	75915	312.002
A1F4	2110-0065		FUSE:0.375A 250V	75915	312.375
A1MP3	00180-61103	1	TRANSISTOR:HEAT SINK RH	28480	00180-61103
A1MP4	00180-61104	1	TRANSISTOR:HEAT SINK LH	28480	00180-61104
A1MP5	00180-00249	1	PANEL:REAR	28480	00180-00249
A1MP6	00182-00206	1	PANEL:ACCESS	28480	00182-00206
A1MP7	00182-24701	4	SPACER:LVPS	28480	00182-24701
A1MP8	00180-01252	1	BRACKET:TRANSFORMER	28480	00180-01252
A1Q1	1854-0417	2	TSTR:SI NPN	28480	1854-0417
A1Q2	1854-0063	2	TSTR:SI NPN	80131	2N3055
A1Q3	1854-0063		TSTR:SI NPN	80131	2N3055
A1Q4	1854-0417		TSTR:SI NPN	28480	1854-0417
A1T1	9100-1129	1	TRANSFORMER:POWER	28480	9100-1129
A1XQ1	1200-0041	4	SOCKET:TRANSISTOR	71785	133-32-10-013
A1XQ2	1200-0041		SOCKET:TRANSISTOR	71785	133-32-10-013
A1XQ3	1200-0041		SOCKET:TRANSISTOR	71785	133-32-10-013
A1XQ4	1200-0041		SOCKET:TRANSISTOR	71785	133-32-10-013
A1A1	00182-66505	1	ASSY:LOW VOLTAGE RECTIFIER BOARD	28480	00182-66505
A1A1C1	0180-1811	1	C:FXD ELECT 100 UF +75-10% 20VDCW	56289	600D107G0200D4
A1A1CR1	1901-0049	5	DIODE:SILICON 50PIV	28480	1901-0049
A1A1CR2	1901-0049		DIODE:SILICON 50PIV	28480	1901-0049
A1A1CR3	1901-0049		DIODE:SILICON 50PIV	28480	1901-0049
A1A1CR4	1901-0049		DIODE:SILICON 50PIV	28480	1901-0049
A1A1CR5	1901-0028	8	DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1A1CR6	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1A1CR7	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1A1CR8	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1A1CR9	1901-0415	8	DIODE:SILICON 50 PIV 3A	28480	1901-0415
A1A1CR10	1901-0415		DIODE:SILICON 50 PIV 3A	28480	1901-0415
A1A1CR11	1901-0415		DIODE:SILICON 50 PIV 3A	28480	1901-0415
A1A1CR12	1901-0415		DIODE:SILICON 50 PIV 3A	28480	1901-0415
A1A1CR13	1901-0415		DIODE:SILICON 50 PIV 3A	28480	1901-0415
A1A1CR14	1901-0415		DIODE:SILICON 50 PIV 3A	28480	1901-0415
A1A1CR15	1901-0415		DIODE:SILICON 50 PIV 3A	28480	1901-0415
A1A1CR16	1901-0415		DIODE:SILICON 50 PIV 3A	28480	1901-0415
A1A1CR17	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1A1CR18	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1A1CR19	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1A1CR20	1901-0028		DIODE:SILICON 0.75A 400PIV	04713	SR1358-9
A1A1CR21	1901-0045	2	DIODE:SILICON 0.75A 100PIV	04713	SR1358-7
A1A1CR22	1901-0045		DIODE:SILICON 0.75A 100PIV	04713	SR1358-7
A1A1R1	0757-0342	2	R:FXD MET FLM 100K OHM 1% 1/4W	28480	0757-0342
A1A1R2	0757-0342		R:FXD MET FLM 100K OHM 1% 1/4W	28480	0757-0342
A1A2	00182-66506	1	ASSY:LOW VOLTAGE REGULATOR BOARD	28480	00182-66506
A1A2C1	0160-0161	2	C:FXD MY 0.01 UF 10% 200VDCW	56289	192P10392-PTS
A1A2C2	0180-0269	1	C:FXD ELECT 1.0 UF +50-10% 150VDCW	56289	30D105F150BA2-DSM
A1A2C3	0180-0089	3	C:FXD AL ELECT 10 UF +50-10% 150VDCW	56289	30D106F150DD2-DSM
A1A2C4	0160-0161		C:FXD MY 0.01 UF 10% 200VDCW	56289	192P10392-PTS
A1A2C5	0180-0058	2	C:FXD AL ELECT 50 UF +75-10% 25VDCW	56289	30D506G025CC2-DSM
A1A2C6	0170-0040	3	C:FXD MY 0.047 UF 10% 200VDCW	56289	192P47392-PTS
A1A2C7	0180-0058		C:FXD AL ELECT 50 UF +75-10% 25VDCW	56289	30D506G025CC2-DSM
A1A2C8			NOT USED		
A1A2C9	0180-0089		C:FXD AL ELECT 10 UF +50-10% 150VDCW	56289	30D106F150DD2-DSM
A1A2CR1	1901-0040	16	DIODE:SILICON 30MA 30WV	07263	FDG1088
A1A2CR2	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1A2CR3	1901-0026	2	DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A1A2CR4	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1A2CR5	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1A2CR6	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1A2CR7	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A1A2E1	2110-0269	10	CLIP:FUSE 0.250" DIA	91506	6008-32CN
A1A2J3	1251-1633	1	CONNECTOR:PC 15 CONTACT	71785	252-15-30-310
A1A2Q1	1854-0039	5	TSTR:SI NPN	80131	2N3053
A1A2Q2	1854-0071	16	TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q4	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q5	1854-0039		TSTR:SI NPN	80131	2N3053

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A2Q6	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q7	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q8	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q9	1854-0039		TSTR:SI NPN	80131	2N3053
A1A2Q10	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q11	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q12	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q13	1854-0039		TSTR:SI NPN	80131	2N3053
A1A2Q14	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q15	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2Q16	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1A2R1	0757-0713	1	R:FXD FLM 110 OHM 1% 1/4W	28480	0757-0713
A1A2R2	0757-0281	6	R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A1A2R3	0757-0465	3	R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1A2R4	0812-0058	2	R:FXD WW 8.2 OHM 5% 2W	28480	0812-0058
A1A2R5	0757-0060	2	R:FXD MET FLM 24.3K OHM 1% 1/2W	28480	0757-0060
A1A2R6	0757-0060		R:FXD MET FLM 24.3K OHM 1% 1/2W	28480	0757-0060
A1A2R7	0757-0435	4	R:FXD FLM 3920 OHM 1% 1/8W	28480	0757-0435
A1A2R8	0757-0438	9	R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1A2R9	0757-0044	2	R:FXD MET FLM 33.2K OHM 1% 1/2W	28480	0757-0044
A1A2R10	0757-0435		R:FXD FLM 3920 OHM 1% 1/8W	28480	0757-0435
A1A2R11	2100-1773	2	R:VAR WW 1K OHM 5% TYPE H 1W	28480	2100-1773
A1A2R12	0757-0767	3	R:FXD FLM 43.2K OHM 1% 1/4W	28480	0757-0767
A1A2R13	0811-1746	2	R:FXD WW 0.36 OHM 5% 2W	28480	0811-1746
A1A2R14	0757-0767		R:FXD FLM 43.2K OHM 1% 1/4W	28480	0757-0767
A1A2R15	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1A2R16	0757-0767		R:FXD FLM 43.2K OHM 1% 1/4W	28480	0757-0767
A1A2R17	0757-0431	3	R:FXD MET FLM 2.43K OHM 1% 1/8W	28480	0757-0431
A1A2R18	0757-0273	1	R:FXD MET FLM 3.01K OHM 1% 1/8W	28480	0757-0273
A1A2R19	0757-0283	7	R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A1A2R20	2100-1772	2	R:VAR WW 500 OHM 5% TYPE H 1W	28480	2100-1772
A1A2R21	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1A2R22	0811-1746		R:FXD WW 0.36 OHM 5% 2W	28480	0811-1746
A1A2R23	0757-0769	3	R:FXD FLM 51.1K OHM 1% 1/4W	28480	0757-0769
A1A2R24	0757-0436	3	R:FXD MET FLM 4.32K OHM 1% 1/8W	28480	0757-0436
A1A2R25	0757-0430	1	R:FXD MET FLM 2.21K OHM 1% 1/8W	28480	0757-0430
A1A2R26	0757-0769		R:FXD FLM 51.1K OHM 1% 1/4W	28480	0757-0769
A1A2R27	0757-0281		R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A1A2R28	0757-0428	2	R:FXD MET FLM 1.62K OHM 1% 1/8W	28480	0757-0428
A1A2R29	2100-1772		R:VAR WW 500 OHM 5% TYPE H 1W	28480	2100-1772
A1A2R30	0757-0435		R:FXD FLM 3920 OHM 1% 1/8W	28480	0757-0435
A1A2R31	0757-0367	3	R:FXD MET FLM 100K OHM 1% 1/2W	28480	0757-0367
A1A2R32	0757-0281		R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A1A2R33	0812-0058		R:FXD WW 8.2 OHM 5% 2W	28480	0812-0058
A1A2R34	0757-0769		R:FXD FLM 51.1K OHM 1% 1/4W	28480	0757-0769
A1A2R35	0757-0768	2	R:FXD FLM 47.5K OHM 1% 1/4W	28480	0757-0768
A1A2R36	0757-0044		R:FXD MET FLM 33.2K OHM 1% 1/2W	28480	0757-0044
A1A2R37	0757-0367		R:FXD MET FLM 100K OHM 1% 1/2W	28480	0757-0367
A1A2R38	0757-0450	1	R:FXD MET FLM 22.1K OHM 1% 1/8W	28480	0757-0450
A1A2R39	0757-0280	8	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1A2R40	2100-1774	1	R:VAR WW 2K OHM 5% TYPE H 1W	28480	2100-1774
A1A2R41	0757-0768		R:FXD FLM 47.5K OHM 1% 1/4W	28480	0757-0768
A1A2TP1	1251-0206	5	CONNECTOR:SOCKET 0.15 BDY DIA TEFLON	98291	SKT-400
A1A2TP2	1251-0206		CONNECTOR:SOCKET 0.15 BDY DIA TEFLON	98291	SKT-400
A1A2TP3	1251-0206		CONNECTOR:SOCKET 0.15 BDY DIA TEFLON	98291	SKT-400
A1A2TP4	1251-0206		CONNECTOR:SOCKET 0.15 BDY DIA TEFLON	98291	SKT-400
A1A2VR1	1902-3096	1	DIODE BREAKDOWN:5.23V 5% 400 MW	28480	1902-3096
A1A2VR2	1902-0787	1	DIODE:T.C. REFERENCE 1N938	04713	1N938
A2	00180-66543	1	BOARD ASSY:HORIZONTAL AMPLIFIER	28480	00180-66543
A2C1	0160-0162	13	C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A2C2	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A2C3	0180-0197	4	C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C4	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C5	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A2C6	0121-0059	1	C:VAR CER 2-8 PF 300VDCW	28480	0121-0059
A2C7	0160-2250	1	C:FXD CER 5.1 PF 500VDCW	72982	301-000-COHO-519E
A2C8	0121-0105	1	C:VAR CER 9-35 PF NPO	28480	0121-0105
A2C9	0140-0205	1	C:FXD MICA 62 PF 5% 300VDCW	00853	RDM15E620J3C
A2C10	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A2C11	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A2C12	0132-0007	3	C:VAR POLY 0.7 TO 3.0 PF 350VDCW	72982	535-033-4R
A2C13	0170-0040		C:FXD MY 0.047 UF 10% 200VDCW	56289	192P47392-PTS
A2C14	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A2C15	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C16	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2C17	0180-0218	1	C:FXD ELECT 0.15 UF 10% 35VDCW	28480	0180-0218
A2C18	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A2C19	0170-0040		C:FXD MY 0.047 UF 10% 200VDCW	56289	192P47392-PTS
A2C20	0132-0007		C:VAR POLY 0.7 TO 3.0 PF 350VDCW	72982	535-033-4R
A2C21	0132-0007		C:VAR POLY 0.7 TO 3.0 PF 350VDCW	72982	535-033-4R
A2C22	0160-2235	1	C:FXD CER 0.75 PF 500VDCW	72982	301-000-COKO-758C
A2CR1	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR2	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR3	5080-0464	4	DIODE:SILICON 30 200M	28480	5080-0464
A2CR4	5080-0464		DIODE:SILICON 30 200M	28480	5080-0464
A2CR5	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR6	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR7	5080-0464		DIODE:SILICON 30 200M	28480	5080-0464
A2CR8	5080-0464		DIODE:SILICON 30 200M	28480	5080-0464
A2CR9	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2E1	5020-0495	75	PIN:SQUARE	28480	5020-0495
A2L1	9140-0179	7	COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A2L2	9140-0179		COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A2L3	9170-0029	1	CORE:FERRITE BEAD	02114	56-590-65A2/4A
A2MP1	1205-0063	3	HEAT SINK:SEMICONDUCTOR	05820	224-CB
A2Q1	1855-0062	1	TSTR:SI FET 30V	01295	2N1595
A2Q2	1854-0215	1	TSTR:SI NPN	80131	2N3904
A2Q3	1850-0158	1	TSTR:GE PNP	80131	2N2635
A2Q4	1854-0019	5	TSTR:SI NPN	28480	1854-0019
A2Q5	1854-0019		TSTR:SI NPN	28480	1854-0019
A2Q6	1853-0009	3	TSTR:SI PNP	28480	1853-0009
A2Q7	1854-0419	2	TSTR:SI NPN	04713	SS657
A2Q8	1853-0038	3	TSTR:SI PNP	28480	1853-0038
A2Q9	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q10	1854-0019		TSTR:SI NPN	28480	1854-0019
A2Q11	1853-0009		TSTR:SI PNP	28480	1853-0009
A2Q12	1854-0419		TSTR:SI NPN	04713	SS657
A2Q13	1853-0038		TSTR:SI PNP	28480	1853-0038
A2R1	0757-0401	9	R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R2	0683-0275	5	R:FXD COMP 2.7 OHM 5% 1/4W	01121	CB 27G5
A2R3	0757-0388	1	R:FXD FLM 30.1 OHM 1% 1/8W	28480	0757-0388
A2R4	0727-0287	1	R:FXD CARBON 2 MEGOHM 1% 1/2W	28480	0727-0287
A2R5	0757-0156	1	R:FXD MET FLM 1.5 MEGOHM 1% 1/2W	28480	0757-0156
A2R6	0757-0344	1	R:FXD MET FLM 1.00 MEGOHM 1% 1/4W	28480	0757-0344
A2R7	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R8	0757-0367		R:FXD MET FLM 100K OHM 1% 1/2W	28480	0757-0367
A2R9	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R10	0757-0407	6	R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A2R11	0761-0074	1	R:FXD MET OX 15K OHM 5% 1W	28480	0761-0074
A2R12	0757-0426	1	R:FXD FLM 1.3K OHM 1% 1/8W	28480	0757-0426
A2R13	0757-0447	1	R:FXD MET FLM 16.2K OHM 1% 1/8W	28480	0757-0447
A2R14	2100-2514	1	R:VAR CERMET 20K OHM 10% LIN 1/2W	28480	2100-2514
A2R15	0698-3153	1	R:FXD MET FLM 3.83K OHM 1% 1/8W	28480	0698-3153
A2R16	0757-0463	1	R:FXD MET FLM 82.5K OHM 1% 1/8W	28480	0757-0463
A2R17	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R18	0757-0792	1	R:FXD MET FLM 681K OHM 1% 1/4W	28480	0757-0792
A2R19	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R20	0757-0460	4	R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A2R21	0757-0441	2	R:FXD MET FLM 8.25K OHM 1% 1/8W	28480	0757-0441
A2R22	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A2R23	0757-0764	1	R:FXD FLM 33.2K OHM 1% 1/4W	28480	0757-0764
A2R24	0757-0741	2	R:FXD MET FLM 2.43K OHM 1%/1/4W	28480	0757-0741
A2R25	0757-0281		R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A2R26	0757-0443	2	R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A2R27	0757-0736	2	R:FXD MET FLM 1.50K OHM 1% 1/4W	28480	0757-0736
A2R28	0757-0413	2	R:FXD MET FLM 392 OHM 1% 1/8W	28480	0757-0413
A2R29	0757-0846	2	R:FXD MET FLM 22.1K OHM 1.0% 1/2W	28480	0757-0846
A2R30	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A2R31	0757-0284	1	R:FXD MET FLM 150 OHM 1% 1/8W	28480	0757-0284
A2R32	2100-1770	1	R:VAR WW 100 OHM 5% TYPE H 1W	28480	2100-1770
A2R33	0757-0411	1	R:FXD MET FLM 332 OHM 1% 1/8W	28480	0757-0411
A2R34	2100-1771	1	R:VAR WW 200 OHM 5% TYPE H 1W	28480	2100-1771
A2R35	0757-0428		R:FXD MET FLM 1.62K OHM 1% 1/8W	28480	0757-0428
A2R36	2100-1773		R:VAR WW 1K OHM 5% TYPE H 1W	28480	2100-1773
A2R37	0698-3416	4	R:FXD MET FLM 21.5K OHM 1% 1/2W	28480	0698-3416
A2R38	2100-0741	1	R:VAR WW 5K OHM 5% 1W	28480	2100-0741
A2R39	0698-3416		R:FXD MET FLM 21.5K OHM 1% 1/2W	28480	0698-3416
A2R40	0757-0434	3	R:FXD MET FLM 3.65K OHM 1% 1/8W	28480	0757-0434
A2R41	0757-0434		R:FXD MET FLM 3.65K OHM 1% 1/8W	28480	0757-0434
A2R42	0757-0448	1	R:FXD MET FLM 18.2K OHM 1% 1/8W	28480	0757-0448

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2R43	0757-0841	2	R:FXD MET FLM 12.1K OHM 1% 1/2W	28480	0757-0841
A2R44	0757-0841		R:FXD MET FLM 12.1K OHM 1% 1/2W	28480	0757-0841
A2R45	0757-0468	3	R:FXD FLM 130K OHM 1% 1/8W	28480	0757-0468
A2R46	0757-0440	1	R:FXD MET FLM 7.50K OHM 1% 1/8W	28480	0757-0440
A2R47	0757-0427	1	R:FXD MET FLM 1.5K OHM 1% 1/8W	28480	0757-0427
A2R48	0757-0741		R:FXD MET FLM 2.43K OHM 1%/1/4W	28480	0757-0741
A2R49	0757-0281		R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A2R50	0757-0200	1	R:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200
A2R51	0757-0443		R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A2R52	0757-0736		R:FXD MET FLM 1.50K OHM 1% 1/4W	28480	0757-0736
A2R53	0757-0846		R:FXD MET FLM 22.1K OHM 1.0% 1/2W	28480	0757-0846
A2R54	0757-0413		R:FXD MET FLM 392 OHM 1% 1/8W	28480	0757-0413
A2R55	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A2R56	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R57	2100-2030	1	R:VAR FLM 20K OHM 10% LIN 1/2W	28480	2100-2030
A2R58	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2S1	3101-0982	1	SWITCH:SLIDE SPST 0.5A 125V	79727	GF124-0007
A3	00180-66542	1	BOARD ASSY:GATE	28480	00180-66542
A3C1	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C2	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C3	0121-0168	2	C:VAR TEFLON 0.25-1.50 PF 600VDCW	28480	0121-0168
A3C4	0160-2240	1	C:FXD CER 2.0 PF 500VDCW	72982	301-000-COKO-209C
A3C5	0121-0168		C:VAR TEFLON 0.25-1.50 PF 600VDCW	28480	0121-0168
A3C6	0140-0178	1	C:FXD MICA 560 PF 2%	72136	RDM15F561G3C
A3C7	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C8	0160-0303	1	C:FXD MYLAR .15 UF 10% 200VDCW	28480	0160-0303
A3C9	0150-0061	1	C:FXD CER 20 PF 10% 100VDCW	56289	53C47
A3C10	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C11	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C12	0180-0155	3	C:FXD ELECT 2.2 UF 20% 20VDCW	56289	150D225X0020A2-DYS
A3C13	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C14	0160-2961	2	C:FXD MICA 5825 PF 2% 300VDCW	04062	RDM20F(5825)G3C
A3C15	0160-2961		C:FXD MICA 5825 PF 2% 300VDCW	04062	RDM20F(5825)G3C
A3C16	0180-0089		C:FXD AL ELECT 10 UF +50-10% 150VDCW	56289	30D106F150DD2-DSM
A3C17	0180-0076	1	C:FXD ELECT 20UF 25VDCW	56289	40D206G025DC6M1
A3C18	0170-0019	1	C:FXD MY 0.1 UF 5% 200VDCW	28480	0170-0019
A3C19	0160-3008	3	C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C20	0160-3007	4	C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C21	0160-3008		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C22	0160-3007		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C23	0160-3007		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C24	0160-3008		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C25	0160-3007		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3CR1	1901-0179	1	DIODE:SILICON 15WV	28480	1901-0179
A3CR2	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR3	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR4	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR5	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR6	1901-0029	2	DIODE:SILICON 600 PIV	28480	1901-0029
A3CR7	1901-0029		DIODE:SILICON 600 PIV	28480	1901-0029
A3CR8	1901-0436	2	DIODE:SILICON 1600 PIV	28480	1901-0436
A3CR9	1901-0436		DIODE:SILICON 1600 PIV	28480	1901-0436
A3CR10	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A3CR11	1901-0096	3	DIODE:SILICON 120V	01295	UG-888
A3CR12	1901-0096		DIODE:SILICON 120V	01295	UG-888
A3CR13	1901-0096		DIODE:SILICON 120V	01295	UG-888
A3E1	5020-0495		PIN:SQUARE	28480	5020-0495
A3L1	9140-0179		COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A3L2	9140-0179		COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A3MP1	1205-0063		HEAT SINK:SEMICONDUCTOR	05820	224-CB
A3Q1	1854-0019		TSTR:SI NPN	28480	1854-0019
A3Q2	1854-0019		TSTR:SI NPN	28480	1854-0019
A3Q3	1853-0038		TSTR:SI PNP	28480	1853-0038
A3Q4	1854-0271	1	TSTR:SI NPN	28480	1854-0271
A3Q5	1853-0009		TSTR:SI PNP	28480	1853-0009
A3Q6	1854-0234	2	TSTR:SI NPN	80131	2N3440
A3Q7	1854-0234		TSTR:SI NPN	80131	2N3440
A3Q8	1854-0023	1	TSTR:SI NPN(SELECTED FROM 2N2484)	28480	1854-0023
A3Q9	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A3Q10	1854-0039		TSTR:SI NPN	80131	2N3053
A3R1	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A3R2	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A3R3	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R4	0757-0458	1	R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A3R5	0757-0281		R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3R6	0757-0435		R:FXD FLM 3920 OHM 1% 1/8W	28480	0757-0435
A3R7	0757-0437	1	R:FXD MET FLM 4750 OHM 1% 1/8W	28480	0757-0437
A3R8	0757-0724	1	R:FXD FLM 392 OHM 1% 1/4W	28480	0757-0724
A3R9	0757-0727	1	R:FXD MET FLM 562 OHM 1% 1/4W	28480	0757-0727
A3R10	0757-0402	1	R:FXD MET FLM 110 OHM 1% 1/8W	28480	0757-0402
A3R11	0698-3416		R:FXD MET FLM 21.5K OHM 1% 1/2W	28480	0698-3416
A3R12	0757-0469	1	R:FXD FLM 150K OHM 1% 1/8W	28480	0757-0469
A3R13	0698-3416		R:FXD MET FLM 21.5K OHM 1% 1/2W	28480	0698-3416
A3R14	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R15	0757-0190	3	R:FXD MET FLM 20K OHM 1% 1/2W	28480	0757-0190
A3R16	0757-0416	1	R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A3R17	0687-1011	1	R:FXD COMP 100 OHM 10% 1/2W	01121	EB 1011
A3R18	0761-0083	1	R:FXD MET OX 68K OHM 5% 1W	28480	0761-0083
A3R19	0757-0441		R:FXD MET FLM 8.25K OHM 1% 1/8W	28480	0757-0441
A3R20	0757-0434		R:FXD MET FLM 3.65K OHM 1% 1/8W	28480	0757-0434
A3R21	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A3R22	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A3R23	0757-0421	1	R:FXD MET FLM 825 OHM 1% 1/8W	28480	0757-0421
A3R24	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R25	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R26	0683-0275		R:FXD COMP 2.7 OHM 5% 1/4W	01121	CB 27G5
A3R27	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R28	0757-0190		R:FXD MET FLM 20K OHM 1% 1/2W	28480	0757-0190
A3R29	0757-0468		R:FXD FLM 130K OHM 1% 1/8W	28480	0757-0468
A3R30	0757-0468		R:FXD FLM 130K OHM 1% 1/8W	28480	0757-0468
A3R31	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A3R32	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A3R33	0757-0190		R:FXD MET FLM 20K OHM 1% 1/2W	28480	0757-0190
A3R34	0698-5421	1	R:FXD MET FLM 17.82K OHM 0.1% 1/2W	28480	0698-5421
A3R35	0698-5418	1	R:FXD FLM 50 OHM 0.1% 1/8W	28480	0698-5418
A3R36	0698-5419	1	R:FXD FLM 1.95K OHM 0.1% 1/8W	28480	0698-5419
A3R37	0683-0275		R:FXD COMP 2.7 OHM 5% 1/4W	01121	CB 27G5
A3R38	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A3R39	0757-0814	1	R:FXD MET FLM 511 OHM 1% 1/2W	28480	0757-0814
A3R40	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R41	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A3R42	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A3R43	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R44	0757-0442	2	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A3R45	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A3R46	0698-3553	1	R:FXD FLM 2.49 MEGOHM 1% 1/2W	28480	0698-3553
A3R47	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A3R48	0757-0870	1	R:FXD MET FLM 825K OHM 1% 1/2W	28480	0757-0870
A3R49	2100-0944	1	R:VAR COMP 200K OHM 20% 3/4W	75042	CT150
A3R50	0687-5611	1	R:FXD COMP 560 OHM 10% 1/2W	01121	EB 5611
A3R51	0698-7182	1	R:FXD MET FLM 30 MEGOHM 1% 2W	28480	0698-7182
A3R52	0683-1055	1	R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055
A3R53	0757-0460		R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A3R54	0757-0456	3	R:FXD MET FLM 43.2K OHM 1% 1/8W	28480	0757-0456
A3R55	0757-0456		R:FXD MET FLM 43.2K OHM 1% 1/8W	28480	0757-0456
A3R56	0757-0460		R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A3R57	0683-5125	1	R:FXD COMP 5100 OHM 5% 1/4W	01121	CB 5125
A3R58	0698-5677	1	R:FXD FLM 8.25 MEGOHM 5% 1W	28480	0698-5677
A3R59	0698-5678	1	R:FXD FLM 16.25 MEGOHM 5% 1W	28480	0698-5678
A3R60	2100-2031	1	R:VAR 50K OHM 10% LIN 1/2W	28480	2100-2031
A3R61	0757-0454	1	R:FXD MET FLM 33.2K OHM 1% 1/8W	28480	0757-0454
A3R62	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R63	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R64	0757-0460		R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A3R65	0757-0456		R:FXD MET FLM 43.2K OHM 1% 1/8W	28480	0757-0456
A3TP1	1251-0206		CONNECTOR:SOCKET 0.15 BDY DIA TEFLON	98291	SKT-400
A3VR1	1902-0025	1	DIODE,BREAKDOWN:10.0V 5% 40C MW	28480	1902-0025
A3VR2	1902-0045	1	DIODE BREAKDOWN:7.32V 2%	28480	1902-0045
A3VR3	2140-0018	2	LAMP:GLOW 1.0 MILLIAMPS 0.1W	08806	A9A-C(NE-2E1)
A3VR4	2140-0018		LAMP:GLOW 1.0 MILLIAMPS 0.1W	08806	A9A-C(NE-2E1)
A4	00180-66541	1	BOARD ASSY:HIGH VOLTAGE OSCILLATOR	28480	00180-66541
A4C1	0180-0097	1	C:FXD TANT. 47 UF 10% 35VDCW	56289	150D476X9035S2-DYS
A4C2	0160-0380	1	C:FXD MY 0.22 UF 10% 200VDCW	28480	0160-0380
A4CR1	1901-0049		DIODE:SILICON 50PIV	28480	1901-0049
A4CR2	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A4E1	5020-0495		PIN:SQUARE	28480	5020-0495
A4E2	2110-0269		CLIP:FUSE 0.250" DIA	91506	6008-32CN
A4L1	9140-0071	1	COIL:FXD RF: 22UHY	28480	9140-0071
A4XQ1	1251-3027	1	CONNECTOR:R & P 3 FEMALE CONTACT	27264	09-52-3032
A5	00180-66544	1	BOARD ASSY:HIGH VOLTAGE RECTIFIER	28480	00180-66544

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A5C1	0160-0907	1	C:FXD CER 0.01 UF +80-20% 5000VDCW	14655	TM50R123Z-1
A5C2	0160-2320	1	C:FXD CER 0.01 UF 5000VDCW	28480	0160-2320
A5CR1	1901-0341	2	DIODE:SI 7000 PIV 50MA	28480	1901-0341
A5CR2	1901-0341		DIODE:SI 7000 PIV 50MA	28480	1901-0341
A5H1	5040-0402	1	MOUNT:TRANSFORMER	28480	5040-0402
A5H2	5040-0430	1	MOUNT:TRANSFORMER	28480	5040-0430
A5H3	0340-0039	2	INSULATOR:BUSHING	28480	0340-0039
A5R1	0683-2235	1	R:FXD COMP 22K OHM 5% 1/4W	01121	CB 2235
A5R2	2100-0918	1	R:VAR COMP 1 MEGOHM 20% LIN 1/5W	28480	2100-0918
A5R3	0836-0003	1	R:FXD FLM 29 MEGOHM 10% 1W	28480	0836-0003
A5T1	00180-60801	1	TRANSFORMER ASSY:HV	28480	00180-60801
A6	00180-61105	2	H.V. MULTIPLIER ASSY(CAB) (NOT FIELD REPAIRABLE)	28480	00180-61105
	00180-61106	1	H.V. MULTIPLIER ASSY(RACK) (NOT FIELD REPAIRABLE)	28480	00180-61106
A7	00180-66546	1	BOARD ASSY:SWEEP GATE	28480	00180-66546
A7C1	0180-0155		C:FXD ELECT 2.2 UF 20% 20VDCW	56289	150D225X0020A2-DYS
A7C2	0180-0155		C:FXD ELECT 2.2 UF 20% 20VDCW	56289	150D225X0020A2-DYS
A7E1	5020-0495		PIN:SQUARE	28480	5020-0495
A7L1	9140-0179		COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A7L2	9140-0179		COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A7Q1	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A7Q2	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A7Q3	1853-0016	2	TSTR:SI PNP	80131	2N3638
A7Q4	1853-0016		TSTR:SI PNP	80131	2N3638
A7R1	0757-0451	2	R:FXD MET FLM 24.3K OHM 1% 1/8W	28480	0757-0451
A7R2	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A7R3	0757-0436		R:FXD MET FLM 4.32K OHM 1% 1/8W	28480	0757-0436
A7R4	0757-0451		R:FXD MET FLM 24.3K OHM 1% 1/8W	28480	0757-0451
A7R5	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A7R6	0757-0436		R:FXD MET FLM 4.32K OHM 1% 1/8W	28480	0757-0436
A7R7	0757-0431		R:FXD MET FLM 2.43K OHM 1% 1/8W	28480	0757-0431
A7R8	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A7R10	0757-0431		R:FXD MET FLM 2.43K OHM 1% 1/8W	28480	0757-0431
A7R11	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A7R12	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A7R13	0683-0275		R:FXD COMP 2.7 OHM 5% 1/4W	01121	CB 27G5
A7R14	0683-0275		R:FXD COMP 2.7 OHM 5% 1/4W	01121	CB 27G5
A7R15	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A8	00180-61904	1	SWITCH ASSY:DISPLAY	28480	00180-61904
A8C1	0160-0168	1	C:FXD MY 0.1 UF 10% 200VDCW	56289	192P10492-PTS
A8L1	9140-0179		COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A8R1			PART OF S1		
A8S1	3100-2543	1	SWITCH:ROTARY 2 POSITION (INCLUDES R1)	28480	3100-2543
A8W1	00180-61652	1	CABLE:COAX, DISPLAY SWITCH	28480	00180-61652
A1	00180-60001		POWER MODULE:LOW VOLTAGE	28480	00180-60001
A1A1	00182-66505		ASSY:LOW VOLTAGE RECTIFIER BOARD	28480	00182-66505
A1A2	00182-66506		ASSY:LOW VOLTAGE REGULATOR BOARD	28480	00182-66506
A2	00180-66543		BOARD ASSY:HORIZONTAL AMPLIFIER	28480	00180-66543
A3	00180-66542		BOARD ASSY:GATE	28480	00180-66542
A4	00180-66541		BOARD ASSY:HIGH VOLTAGE OSCILLATOR	28480	00180-66541
A5	00180-66544		BOARD ASSY:HIGH VOLTAGE RECTIFIER	28480	00180-66544
A6	00180-61105		H.V. MULTIPLIER ASSY(CAB)	28480	00180-61105
	00180-61106		H.V. MULTIPLIER ASSY(RACK)	28480	00180-61106
A7	00180-66546		BOARD ASSY:SWEEP GATE	28480	00180-66546
A8	00180-61904		SWITCH ASSY:DISPLAY	28480	00180-61904
C1	0170-0022	1	C:FXD MY 0.1UF 20% 600VDCW	09134	TYPE 24
C2	0160-3484	2	C:FXD CER FEED-THRU 1000 PF 20% 1000V	72982	2432-009 X5U 102M
C3	0160-3484		C:FXD CER FEED-THRU 1000 PF 20% 1000V	72982	2432-009 X5U 102M
DS1	2140-0346	1	LAMP:INCANDESCENT 5V	71744	7210
E1	0340-0450	1	WASHER:TRANSISTOR INSULATOR	04713	14B52600F12
E2	0340-0451	1	WASHER:INSULATED, TRANSISTOR	04713	14B52600F03
E3	0362-0227	68	TERMINATION:CRIMP LUG FOR 26 AWG WIRE	27264	2125
E4	1251-2039	9	CONNECTOR: CRT NECK PIN	28480	1251-2039
E5	0362-0277	2	TERMINATION:CRIMP LUG (CRT FIL LEADS)	59730	A18-187
F1	2110-0020	1	FUSE:0.8A 250V SLOW-BLOW (230V OPERATION)	75915	313.800S
	2110-0005	1	FUSE:CARTRIDGE 1.6 AMP 125V (115V OPERATION)	71400	MDL 1.6
F2	2110-0033	1	FUSE:0.75A 250V	75915	F02GR750A
J1	1251-0137	1	CONNECTOR:PC 32 CONTACT PART OF W6	02660	26-4200-32S
J2	1251-0172	1	CONNECTOR:PC EDGE 1 ROW 22 CONTACT PART OF W6	71785	250-22-30-210

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
J3			NSR, PART OF MP42, MP80.		
J4			NSR, PART OF MP42, MP80.		
J5	1510-0038	2	BINDING POST	28480	1510-0038
J6	1250-0083	6	CONNECTOR:BNC	02660	31-221-1020
J7	1250-0083		CONNECTOR:BNC	02660	31-221-1020
J8	1250-0083		CONNECTOR:BNC	02660	31-221-1020
J9	1250-0083		CONNECTOR:BNC	02660	31-221-1020
J10	1250-0083		CONNECTOR:BNC	02660	31-221-1020
J11	1250-0083		CONNECTOR:BNC	02660	31-221-1020
J12	1251-2357	1	SOCKET:3-PIN MALE POWER RECEPTACLE	82389	EAC-301
J13	1510-0038		BINDING POST	28480	1510-0038
J14	0363-0006	2	CONTACT:CONNECTOR SWITCH	28480	0363-0006
L1	00180-65601	1	COIL ASSY:Y ALIGNMENT	28480	00180-65601
L2	5060-0435	1	COIL:ALIGNMENT Z AXIS	28480	5060-0435
L3	9170-0013	1	COIL:CORE, TOROID, GREEN	72656	CF-102-H
MP1	10179A	1	CONTRAST IMPROVEMENT SCREEN	28480	10179A
MP2	5040-0444	1	SHIELD:LIGHT BLACK NYLON	28480	5040-0444
MP3	5020-0476	1	BEZEL:CRT	28480	5020-0476
MP4	00180-04130	1	COVER:BTM RIGHT	28480	00180-04130
MP5	00180-04132	1	COVER:BTM LEFT	28480	00180-04132
MP6	00180-04134	1	COVER:TOP RIGHT	28480	00180-04134
MP7	00180-04136	1	COVER:TOP LEFT	28480	00180-04136
MP8	0370-0432	1	KNOB:BLACK LEVER	28480	0370-0432
MP9	00180-05002	1	LEVER:HORIZONTAL POSITION	28480	00180-05002
MP10	00180-67402	2	KNOB:HORIZONTAL POSITION	28480	00180-67402
MP11	00180-67404	2	KNOB ASSY:BAR WITH BLACK ARROW	28480	00180-67404
MP12	00180-67404		KNOB ASSY:BAR WITH BLACK ARROW	28480	00180-67404
MP13	00180-67405	1	KNOB:RND BLK (FIND BEAM)	28480	00180-67405
MP14	0370-0348	1	KNOB:RND BLK 0.540" DIA	28480	0370-0348
MP15	00180-67403	1	KNOB ASSY	28480	00180-67403
MP16	00180-67402		KNOB:HORIZONTAL POSITION	28480	00180-67402
MP17	0403-0128	1	GUIDE:PC BD PLUG-IN(LEFT)	28480	0403-0128
MP18	0403-0129	1	GUIDE:PC BD PLUG-IN(RIGHT)	28480	0403-0129
MP19	0510-0705	2	PIN:SPRING 0.094" DIA	00287	OBD#
MP20	0510-0952	2	RING:RETAINING STL FOR 0.094" DIA SHAFT	79136	X5133-9-S-MD
MP21	1460-0706	2	SPRING:COMPRESSION	00000	OBD
MP22	3050-0441	2	WASHER:SHOULDER .125 ID FOR #4 HDW	28480	3050-0441
MP23	5020-0499	2	HINGE:PROBE HANGER	28480	5020-0499
MP24	5040-0463	2	HANGER:PROBE	28480	5040-0463
MP25	5040-0464	2	HANGER:PROBE	28480	5040-0464
MP26	5040-0459	1	HANDLE	28480	5040-0459
MP27	00180-24718	2	SPACER:HANDLE	28480	00180-24718
MP28	00180-22301	2	KEEPER:HANDLE	28480	00180-22301
MP29	00180-09103	2	SPRING:INSERT	28480	00180-09103
MP30	00180-07201	2	INSERT:KEEPER	28480	00180-07201
MP31	4320-0231	1	RUBBER:RFI	00000	OBD#
MP32	00180-60118	1	CHASSIS:CAB POWER	28480	00180-60118
MP33	00180-60117	1	CHASSIS:CAB DISPLAY	28480	00180-60117
MP34	00180-24728	1	SPACER:FRONT	28480	00180-24728
MP35	00180-24727	1	SPACER:REAR	28480	00180-24727
MP36	00180-24726	2	SPACER:SIDE	28480	00180-24726
MP37	7120-1254	1	TRADEMARK	28480	7120-1254
MP38	5040-0445	2	FOOT:BOTTOM	28480	5040-0445
MP39	5040-0446	2	FOOT:REAR, SHORT,	28480	5040-0446
MP40	5040-0447	2	FOOT:REAR(LONG)	28480	5040-0447
MP41	00180-00602	1	SHIELD:CRT	28480	00180-00602
MP42	00180-00245	1	PANEL:FRONT(CAB)	28480	00180-00245
MP43	00180-00247	1	PANEL:FRONT, SUB	28480	00180-00247
MP44	0400-0010	2	GROMMET:VINYL 0.250" ID	00000	OBD#
MP45	1400-0026	1	CLAMP:HOSE	66295	36H
MP46	00180-41207	2	BRACKET:PLASTIC	28480	00180-41207
MP47	00180-09104	2	CLIP:GROUND	28480	00180-09104
MP48	00180-23701	1	SHAFT:BEAM FINDER	28480	00180-23701
MP49	00180-01253	1	BRACKET:BEAM FIND	28480	00180-01253
MP50	5040-0453	1	COVER:POTENTIOMETER(FOCUS)	28480	5040-0453
MP51	00180-01209	1	BRACKET:CONNECTOR PLUG-IN	28480	00180-01209
MP52	00180-01218	2	BRACKET:ALIGNMENT COIL	28480	00180-01218
MP53	00180-04128	1	COVER:HV PLATE	28480	00180-04128
MP54	00180-25402	1	PLEXIGLASS	28480	00180-25402
MP55	00180-25703	1	NUT:HORIZONTAL POSITION POT	28480	00180-25703
MP56	1400-0325	2	CLAMP:CABLE 0.125" DIA	00000	OBD
MP57	00180-44701	1	SPACER:TRADEMARK	28480	00180-44701

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
MP58	00180-24702	1	STANDOFF:GATE INSULATING	28480	00180-24702
MP59	0570-0031	1	SCREW:RND HD SLOT DR 4-40 INSULATING	00000	OBD
MP60	0400-0010		GROMMET:VINYL 0.250" ID	00000	OBD#
MP61	2200-0762	20	SCREW:TRUSS HD POZI DR 4-40 X 0.250" LG	00000	OBD
MP62	2200-0140	22	SCREW:FLAT HD POZI DR 4-40 X 0.250" LG	00000	OBD
MP63	2360-0192	12	SCREW:FLAT HD POZI DR 6-32 X 0.250"	00000	OBD
MP64	0590-0043	2	NUT:HEX 1/4 X 32 INTERNAL THREAD	00866	OBD
MP65	1490-0968	2	BUSHING:POTENTIOMETER 1/4-32 EXT THRD	00000	OBD
MP66	00180-04138	1	COVER:TOP(RACK)	28480	00180-04138
MP67	00180-04137	2	COVER:SIDE(RACK)	28480	00180-04137
MP68	00180-01217	2	BRACKET:COVER	28480	00180-01217
MP69	5060-0431	2	FRAME ASSY:SIDE	28480	5060-0431
MP70	5000-0051	2	TRIM STRIP	28480	5000-0051
MP71	00180-00601	1	SHIELD:POST ACCELERATOR	28480	00180-00601
MP72	00180-60119	1	CHASSIS ASSY:DISPLAY(RACK)	28480	00180-60119
MP73	00180-60120	1	CHASSIS ASSY:POWER(RACK)	28480	00180-60120
MP74	5000-0449	1	SPACER:FRONT	28480	5000-0449
MP75	5000-0469	1	SPACER:REAR	28480	5000-0469
MP76	00180-64110	1	COVER ASSY:BOTTOM	28480	00180-64110
MP77	1490-0030	1	STAND:TILT	28480	1490-0030
MP78	5060-0767	5	FOOT ASSY:FM	28480	5060-0767
MP79	5060-0775	1	KIT:5 H RACK MOUNT	28480	5060-0775
MP80	00180-00246	1	PANEL:FRONT(RACK)	28480	00180-00246
MP81	00180-01255	1	BRACKET:BRACE	28480	00180-01255
MP82	00180-01246	1	BRACKET:GROUND LINE FILTER	28480	00180-01246
MP83	00182-01209	1	BRACKET:LINE FILTER	28480	00182-01209
MP84	00182-00601	1	SHIELD:LINE FILTER	28480	00182-00601
MP85	1450-0404	1	LENS:CLEAR	28480	1450-0404
MP86	00180-01249	1	BRACKET:VERTICAL LEADS	28480	00180-01249
MP87	00180-01251	1	BRACKET:TRANSISTOR	28480	00180-01251
MP88	00180-41208	1	CLIP:HORIZONTAL	28480	00180-41208
MP89	00180-01250	1	BRACKET:VERTICAL LEADS	28480	00180-01250
MP90	1490-0710	1	STAND:TILT (CAB)	28480	1490-0710
MP91	00180-09105	1	CLIP:GROUND	28480	00180-09105
MP92	1400-0090	1	WASHER:RUBBER 5/8" OD	00000	OBD
MP93	00180-60201	1	PANEL ASSY:REAR (INCLUDES J12, MP84, S5)	28480	00180-60201
Q1	1854-0320	1	TSTR:SI NPN	28480	1854-0320
R1	2100-2076	1	R:VAR COMP 2 X 100K OHM 20% LIN	28480	2100-2076
R2	2100-1904	1	R:VAR COMP 10K OHM 20% LIN 1/4W	28480	2100-1904
R3	2100-3147	1	R:VAR COMP 5 MEGOHM 20% LIN	28480	2100-3147
R4	0683-1045	1	R:FXD COMP 100K OHMS 5% 1/4W	01121	CB 1045
R5	2100-1905	1	R:VAR COMP 50K OHM 20% LIN 1/2W	28480	2100-1905
R6	2100-1903	1	R:VAR WW 5K OHM 10% LIN 2W	28480	2100-1903
R7	2100-1901	1	R:VAR WW 100 OHM 10% LIN 2W	28480	2100-1901
S1	3101-1508	1	SWITCH:TOGGLE DPDT	09353	7318I
S2	3101-0070	1	SWITCH:SLIDE	79727	G-126
S3	3100-1345	1	SWITCH:ROTARY 1 SECTION 3 POSITION	28480	3100-1345
S4	3101-0977	1	SWITCH:PUSHBUTTON DPDT	82389	12S-1032
S5	3101-1237	1	SWITCH:SLIDE DPDT	82389	11A-1243
V1	5083-3552	1	CRT:P31 ALUMINIZED INT GRAT	28480	5083-3552
W1	8120-1538	1	CABLE ASSY:POWER 7.5 FT. (CAB)	28480	8120-1538
	8120-1545	1	CABLE ASSY:AC POWER CORD 7.5 FT (RACK)	70903	KH 7171
W2	00180-61616	1	CABLE ASSY:COAX VERTICAL (CAB)	28480	00180-61616
	00180-61617	1	CABLE ASSY:COAX VERTICAL (RACK)	28480	00180-61617
W3	00180-61685	1	CABLE:CRT	28480	00180-61685
W4	00180-61650	1	CABLE ASSY:SWEEP OUT	28480	00180-61650
W5	00180-61651	1	CABLE ASSY:HORIZONTAL (CAB)	28480	00180-61651
	00180-61656	1	CABLE ASSY:HORIZONTAL (RACK)	28480	00180-61656
W6	00180-61694	1	CABLE ASSY:MAIN(CAB)	28480	00180-61694
	00180-61695	1	CABLE:MAIN(RACK)	28480	00180-61695
W7	00180-61657	1	CABLE ASSY:HORIZONTAL MAGNIFIER	28480	00180-61657
W8	00180-61696	1	CABLE ASSY:4-COND(RACK) (S4 TO J2)	28480	00180-61696
	00180-61697	1	CABLE ASSY:4-COND(CAB) (S4 TO J2)	28480	00180-61697
			PART OF W6		
W9	00180-61698	1	CABLE ASSY:4-COND(RACK) (INCLUDES L3)	28480	00180-61698
	00180-61699	1	CABLE ASSY:4-COND(CAB) (INCLUDES L3)	28480	00180-61699
			PART OF W6		
W10	00180-61609	1	CABLE:COAX, (EXT INPUT)	28480	00180-61609
			PART OF W6		
W11	00180-61646	1	CABLE:COAX, BLUE (MAIN GATE)	28480	00180-61646
W12	00180-61647	1	CABLE:COAX, WHITE(DELAYED GATE)	28480	00180-61647
W13	00180-61648	1	CABLE:COAX, YELLOW (DELAYED SWEEP)	28480	00180-61648
W14	00180-61649	1	CABLE:COAX, RED (MAIN SWEEP)	28480	00180-61649
W15	00180-61801	1	CABLE:COAX, YELLOW(Z-AXIS INPUT)	28480	00180-61801
			PART OF W6		
W16			NOT USED		
W17	00180-61642	1	CABLE:COAX, RED-ST (ALT TRIGGER) (CAB)	28480	00180-61642
	00180-61638	1	CABLE:COAX, RED-ST (ALT TRIGGER) (RACK)	28480	00180-61638
			PART OF W6		

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
W18	00180-61640	1	CABLE:COAX, BLUE-ST (UNBLANK GATE) (RACK)	28480	00180-61640
	00180-61644	1	CABLE:COAX, BLUE-ST (UNBLANK GATE) (CAB)	28480	00180-61644
W19	00180-61643	1	CABLE:COAX, BLACK-ST (CHOP BLANK) (CAB) PART OF W6	28480	00180-61643
	00180-61641	1	CABLE:COAX, BLACK-ST (CHOP BLANK) (RACK) PART OF W6	28480	00180-61641
W20	00180-61645	1	CABLE:SHIELDED (CALIBRATOR) PART OF W6	28480	00180-61645
XDS1	00183-67701	1	BASE:PILOT LIGHT	28480	00183-67701
XF1	1400-0084	1	FUSEHOLDER:EXTRACTOR POST TYPE	75915	342014
XV1			PART OF W6. CONSISTS OF:		
	1200-0037	1	SOCKET:CRT TUBE	72825	97097
	1200-0050	7	CONTACT:CRT SOCKET	72825	9553-1
	1200-0408	1	COVER:CRT SOCKET	28480	1200-0408

See introduction to this section for ordering information

Table 6-3. List of Manufacturers' Codes

MFR NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
00000	U.S.A. COMMON	ANY SUPPLIER OF U.S.A.	
00287	CEMCO	DANIELSON, CONN.	06239
00853	SANGAMO ELECTRIC CO.PICKENS DIV.	PICKENS, S.C.	29671
00866	GOE ENGINEERING CO. INC.	CITY OF INDUSTRY, CALIF.	91746
01121	ALLEN BRADLEY CO.	MILWAUKEE, WIS.	53204
01295	TEXAS INSTRUMENTS INC. SEMICONDUCTOR COMPONENTS DIV.	DALLAS, TEX.	75231
02114	FERROXCUBE CORP.	SAUGERTIES, N.Y.	12477
02660	AMPHENOL CORP.	BROADVIEW, ILL.	60153
04062	ARCO ELECTRONIC INC.	GREAT NECK, N.Y.	08718
04713	MOTOROLA SEMICONDUCTOR PROD.INC.	PHOENIX, ARIZ.	85008
05820	WAKEFIELD ENGINEERING INC.	WAKEFIELD, MASS.	01880
07263	FAIRCHILD CAMERA & INST. CORP. SEMICONDUCTOR DIV.	MOUNTAIN VIEW, CALIF.	94040
08806	G.E. CO. MINIATURE LAMP DEPT.	CLEVELAND, OHIO	44112
09134	TEXAS CAPACITOR CO. INC.	HOUSTON, TEX.	77042
09353	C & K COMPONENTS INC.	NEWTON, MASS.	02158
14655	CORNELL DUBLIER ELECT. DIV.FEDERAL PACIFIC ELECT. CO.	NEWARK, N.J.	07105
27264	MOLEX PROD. CO.	DOWNERS GROVE, ILL.	60515
28480	HEWLETT-PACKARD COMPANY	PALO ALTO, CALIF.	94304
56289	SPRAGUE ELECTRIC CO.	N. ADAMS, MASS.	01247
59730	THOMAS & BETTS CO. THE	ELIZABETH, N.J.	07207
66295	WITTEK MFG. CO.	CHICAGO, ILL.	60623
70903	BELDEN CORP.	CHICAGO, ILL.	60644
71400	BUSSMANN MFG. DIV. MC GRAW-EDISON CO.	ST. LOUIS, MO.	63017
71744	CHICAGO MINIATURE LAMP WORKS	CHICAGO, ILL.	60640
71785	CINCH MFG. CO. DIV TRW INC.	ELK GROVE VILLAGE, ILL.	
72136	ELECTRO MOTIVE MFG. CO. INC.	WILLIMANTIC, CONN.	06226
72656	INDIANA GENERAL CORP. ELECTRONIC DIV.	KEASBEY, N.J.	08832
72825	EBY HUGH H. INC.	PHILADELPHIA, PA.	19144
72982	ERIE TECHNOLOGICAL PROD. INC.	ERIE, PA.	16512
75042	INTERNATIONAL RESISTANCE CO. INC.	PHILADELPHIA, PA.	19108
75915	LITTELFUSE INC.	DES PLAINES, ILL.	60016
79136	WALDES KOHINOOR INC.	LONG IS. CITY, N.Y.	11101
79727	CONTINENTAL-WIRT ELECTRONICS CORP.	PHILADELPHIA, PA.	19144
80131	ELECTRONIC INDUSTRIES ASSOCIATION	WASHINGTON D.C.	20006
82389	SWITCHCRAFT INC.	CHICAGO, ILL.	60630
91506	AUGAT INC.	ATTLEBORO, MASS.	02703
95354	METHODE MFG. CO.	ROLLING MEADOWS, ILL.	60008
98291	SEALECTRO CORP.	MAMARONECK, N.Y.	10544

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. INTRODUCTION.

7-2. This section contains information required to backdate or update this manual for a specific instrument. Descriptions of special options and standard options are also in this section.

7-3. MANUAL CHANGES.

7-4. This manual applies directly to the instrument having a serial prefix as shown on the manual title page. If the serial prefix of the instrument is not the same as the one on the title page, refer to Table 7-1 for changes necessary to backdate the manual to the instrument. When making changes from Table 7-1, make the change with the highest number first. If the serial prefix of the instrument is not listed either in the title page or in Table 7-1, refer to an enclosed MANUAL CHANGES sheet for updating information. Also, if a MANUAL CHANGES sheet is supplied, make all indicated ERRATA corrections.

Table 7-1. Manual Changes

Serial Prefix	Make Changes
No backdating changes are required at this time.	

7-5. SPECIAL OPTIONS.

7-6. Most customer special application requirements and/or specifications can be met by factory modification of a standard instrument. A standard instrument modified in this way will carry a special option number, such as Model 0000A/Option C01.

7-7. An operating and service manual and a manual insert are provided with each special option instrument. The operating and service manual contains information about the standard instrument. The manual insert for the special option describes the factory modifications required to produce the special option instrument. Amend the operating and service manual by changing it to include all manual insert information (and MANUAL CHANGES sheet information, if applicable). When these changes are made, the operating and service manual will apply to the special option instrument.

7-8. If you have ordered a special option instrument and the manual insert is missing, notify the nearest Hewlett-Packard Sales/Service Office. Be sure to give a full description of the instrument, including the complete serial number and special option number.

7-9. STANDARD OPTIONS.

7-10. Standard options are modifications installed on HP instruments at the factory and are available on request. Contact the nearest Hewlett-Packard Sales/Service Office for information concerning standard options.

7-11. The following standard options are presently available:

Option 002: equipped with aluminized P2 phosphor internal graticule CRT, HP Part No. 5083-3522.

Option 003: operation with 100/200V input power. If replacement of the entire low voltage Power Supply module A1 is desired, order HP Part No. 00180-60004. Power transformer A1T1 is replaced by HP Part No. 9100-3249, and Rear Panel assembly MP43 is replaced by HP Part No. 00180-60202.

Option 007: equipped with aluminized P7 phosphor internal graticule CRT, HP Part No. 5083-3532. An amber CRT filter, HP Part No. 5020-0530, is also provided.

Option 010: deletes rear panel outputs for main and delayed gates and main and delayed sweeps.

Option 011: equipped with aluminized P11 phosphor internal graticule CRT, HP Part No. 5083-3542.

Option 602: equipped with aluminized P2 phosphor non-graticule CRT, HP Part No. 5083-3521.

Option 607: equipped with aluminized P7 phosphor non-graticule CRT, HP Part No. 5083-3531. An amber CRT filter, HP Part No. 5020-0530, is also supplied.

Option 611: equipped with aluminized P11 phosphor non-graticule CRT, HP Part No. 5083-3541.

Option 631: equipped with aluminized P31 phosphor non-graticule CRT, HP Part No. 5083-3551.

7-12. OPTION 011 and 611. The intensification function of the FIND BEAM switch is deleted on option 011 and 611 instruments equipped with a P11 phosphor CRT to eliminate possible phosphor burn. If the CRT is replaced with a standard P31 phosphor CRT, the FIND BEAM intensification function may be restored. Resistor A2R5 is removed on instruments with option 011 or 611. The beam will not be intensified on these instruments when the FIND BEAM pushbutton is depressed. To determine beam location, increase the INTENSITY control setting while pressing FIND BEAM.

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains schematics, repair and replacement information, component identification illustrations, and troubleshooting and repair information. Table 8-1 defines symbols and conventions used on the schematics. The overall block diagram is located in Section IV.

8-3. SCHEMATICS.

8-4. Schematics appear on right-hand pages that unfold outside the right edge of the manual. This allows viewing the schematics while referring to text and figures in another section of the manual.

8-5. The schematics are drawn primarily to show the electronic function of the circuit and instrument. A given schematic may include all or part of several assemblies. Schematics also include dc voltages and waveforms at helpful points. Information explaining the symbols and conventions used in these schematics is provided by Table 8-1. Voltage measurement conditions applicable to each schematic are shown next to the schematic.

8-6. Each schematic is identified by a number. The number of the schematic is located in the lower right-hand corner near the figure number and title. These numbers are used to make it easy to trace a circuit that begins on one schematic and is continued on another. When a circuit leaves a schematic, it is identified with the code number of the schematic on which it is continued. Both schematics have the same circuit identification information such as voltage, function or circuit connection.

8-7. REFERENCE DESIGNATIONS.

8-8. The unit system of reference designations used in this manual is in accordance with provisions of the USA Standard Reference Designations for Electrical and Electronic Parts and Equipments dated March 1, 1968. Minor variations due to design and manufacturing practices not specifically covered by the standard may be noted.

8-9. Each electrical component is identified by a class letter and number. This letter-number combination is the basic designation for each component. Components that are separately replaceable and are part of an assembly have, in addition to the basic designation, a prefix designation indicating the assembly on which the component is physically located. Components not located on an assembly will have only the basic designation and are listed in the replaceable parts list (Section VI) under chassis parts.

8-10. All components within the shaded areas on the schematics are physically located on an etched circuit board and should be prefixed with the assembly number assigned to the board (e.g. resistor R23 on assembly A3 is referred to as A3R23). There may also be an R23 on several other assemblies, but the assembly designation will always be different (A2R23, A1R23, etc.).

8-11. COMPONENT LOCATION.

8-12. All adjustments are shown in Section V, and mechanical and miscellaneous electrical parts are shown on exploded view drawings in Section VI. For ready reference, circuit assembly photographs are placed adjacent to the associated schematics.

8-13. Circuit assembly photographs are subdivided by a grid, and components within each subdivision are indexed to a location table near the photograph. A component can be easily located on the photograph by first referring to the table. However, reference designators are not complete on the assembly photographs. For the complete reference designator, prefix the assembly designation given in the photograph to each component designator.

8-14. TROUBLESHOOTING.

8-15. The most important prerequisite for successful troubleshooting is understanding how the instrument operates and correct usage of controls.

8-16. Equipment troubles are frequently due simply to improper front-panel control settings. Refer to the operating instructions in Section III for a complete explanation of each control function along with typical operating instructions, if in doubt. Use the controls as a guide to help isolate a trouble to a specific area of the instrument.

8-17. Troubleshooting is easier if more than one symptom of a trouble is evident. Observe the instrument, and note all indications of faulty operation. If symptoms indicate more than one trouble, treat each problem individually and locate one trouble at a time. Don't waste time making random checks. Follow the procedure presented here, and refer to other areas of information in this manual if necessary.

8-18. Make a thorough check of instrument performance. A complete procedure is given in Section V, and forms are included to record results. A trouble, such as incorrect vertical gain or sweep speed, may be due to lack of calibration.

8-19. PRELIMINARY CHECKOUT.

8-20. To help isolate malfunctions, perform the following checkout procedure:

a. Check for improper control settings (refer to Section III).

b. Check for proper operation of accessory equipment.

c. Visually inspect instrument for loose wire and cable connections. Check wiring to all board assemblies for proper connections.

d. Visually inspect for burned, broken or chafed wires; charred or discolored components; and any other indication of physical damage.

e. Check for proper power supply voltages and determine that fuses are not open.

8-21. DETAILED CHECKOUT.

8-22. If the trouble cannot be located using the preliminary checkout procedures, a detailed check of the circuits will be necessary. Troubleshooting charts, waveforms, and voltages are provided to help in locating problem areas and components. The troubleshooting charts and waveforms are to be used to isolate the problem to a specific area. The voltages can then be used to locate the faulty component within the problem area.

CAUTION

When taking waveform or dc voltage measurements, use extreme care to avoid shorting supply voltages or components.

8-23. DC VOLTAGES.

8-24. Dc voltages are shown on the schematics for active components (transistors, etc.). Conditions under which the typical voltages were taken are listed adjacent to each schematic. Since these conditions may differ from one circuit to another, always check the specific conditions listed. The conditions have been set up to permit the greatest amount of troubleshooting voltage information possible.

8-25. WAVEFORMS.

8-26. Waveform measurement points ( with a number enclosed) are placed on the schematics at helpful locations. The numbers inside the measurement point symbols are keyed to corresponding waveforms adjacent to the schematic. Conditions for making the waveform measurement are also given if pertinent.

8-27. TEST POINTS.

8-28. Test points are shown on the schematics with this symbol (). These symbols refer to specific test point pins which are a part of the etched circuit board assembly. They do not correspond to the waveform measurement points.

8-29. POLARIZED COMPONENTS.

8-30. As an aid to locating measurement points and identifying the proper orientation of components, a small dot etched on the circuit board is used to guide the service technician. Use these points to assist you in making voltage and resistance measurement checks and as guidance in properly replacing components. The dot is etched next to:

emitter lead of each transistor,

source lead of FET's,

cathode end of diodes,

positive end of electrolytics.

8-31. TROUBLESHOOTING TABLES.

8-32. Troubleshooting tips are given in several tables. The tables are not intended as a fool-proof tool for pinpointing every possible trouble. Some of the most common symptoms and probable faults are given. Before doing the checks, be sure that the symptom is valid by checking control settings. For example, what may at first appear as no display may really be a no-sweep problem.

8-33. REPAIR AND REPLACEMENT.

8-34. The following paragraphs contain recommended procedures for repair and replacement of defective components. A complete list of components, with Hewlett-Packard part numbers and ordering information, is in Section VI. Contact the nearest HP Sales/Service Office listed at the rear of this manual if satisfactory repair or operation cannot be achieved.

8-35. SERVICING ETCHED CIRCUIT BOARDS.

8-36. Etched circuit boards in this instrument have components mounted on one side of the board, conductive surfaces on both sides, and plated-through component mounting holes. Hewlett-Packard Service Note M-20E contains useful information on servicing etched circuit boards. Some important considerations are as follows:

a. Use a 37 to 47.5 watt chisel tip soldering iron with a tip diameter of 1/16 to 1/8 inch, and a small diameter rosin core solder.

b. Components may be removed by placing the soldering iron on the component leads on either side of the board and pulling the component straight away from the board. If heat is applied to the component side of the board, greater care is required to avoid damage to the components, especially semiconductors. Heat damage may

be minimized by gripping the lead with long-nose pliers between the soldering iron and the component, thereby forming a heat sink.

c. If a component is obviously damaged or faulty, clip the leads close to the component and then unsolder the leads from the board.

d. Large components, such as potentiometers, may be removed by rotating the soldering iron from lead to lead while applying steady pressure to lift the part free. The alternative is to clip the leads of the damaged part and remove them individually.

e. Excessive heat or force will destroy the laminate bond between the metal-plated surface (conductor) and the board. If this problem should occur, the lifted conductor may be cemented down with a small amount of quick-drying, acetate-base cement having good insulating properties. Another method of repair is to solder a section of good conducting wire along the damaged area.

f. Before replacing a component, heat the remaining solder in the component hole and clean it out. Sharp-pointed metallic tools are not recommended since they may loosen eyelets in boards or remove plating from the inside of holes on plated-through etched circuit boards.

g. Tin and shape replacement component leads to fit existing holes.

h. Install the replacement component in the same position as the original.

8-37. SEMICONDUCTOR REPLACEMENT.

8-38. Semiconductor devices are available in a wide variety of shapes and sizes. This can make it confusing to identify the leads. Examples of some of the most common configurations are shown in Figure 8-1.

8-39. When removing a semiconductor, use long-nose pliers as a heat sink between the device and the soldering iron. When replacing a semiconductor, ensure sufficient lead length to dissipate soldering heat by using the same length of exposed lead as used for the original part.

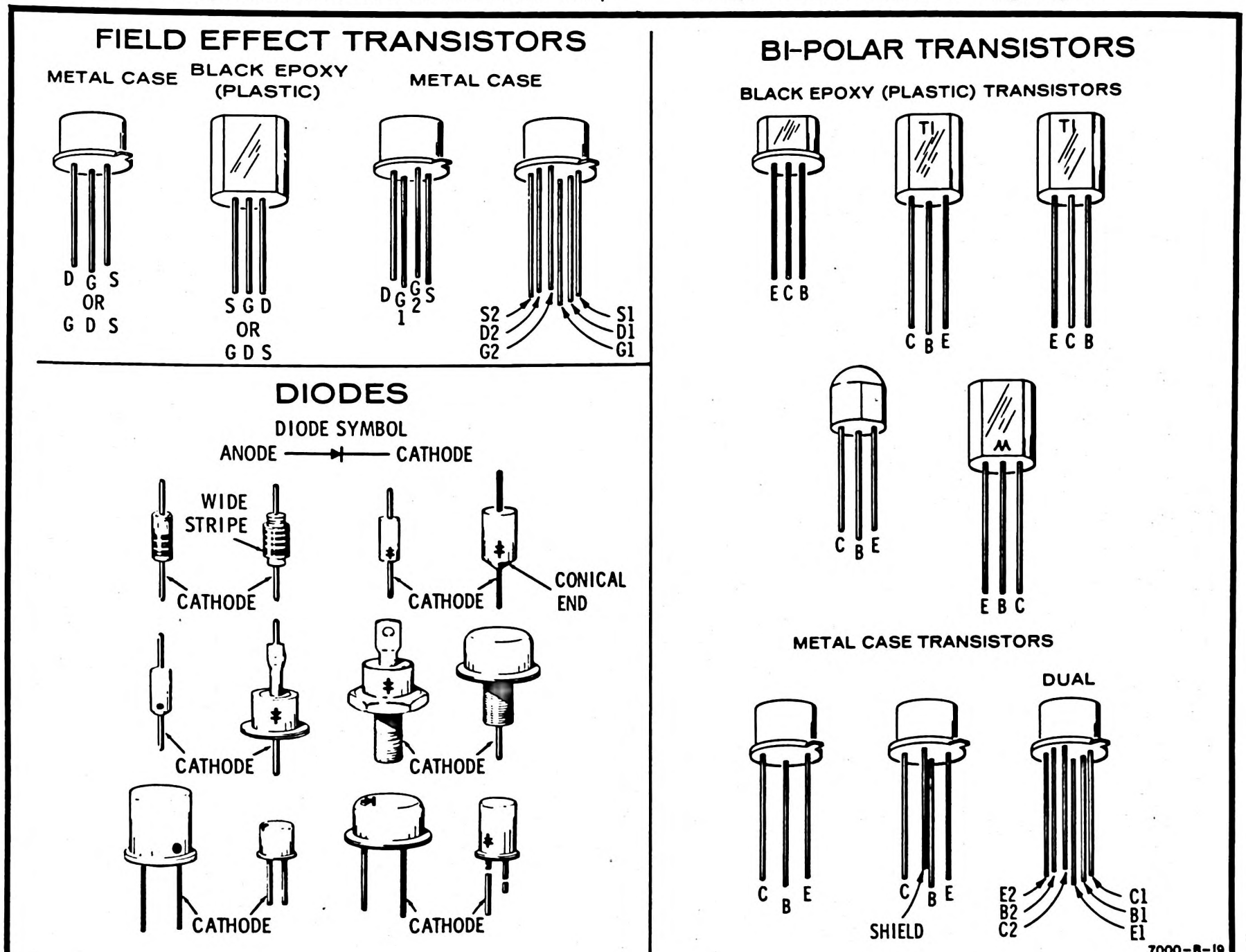


Figure 8-1. Semiconductor Terminal Identification

8-40. DETAILED TROUBLESHOOTING.

8-41. The following troubleshooting tips are categorized according to the various areas of the instrument. These tips can be helpful only after a trouble is localized to one of these areas. Read the theory of operation in Section IV to learn how a circuit should operate. With the aid of this information, it is easier to discover why a defective circuit is inoperative. Finally, make resistance checks to uncover the faulty component. If it appears necessary to calibrate the instrument, refer to Section V for the proper procedures.

4-42. LOW VOLTAGE POWER SUPPLY.

8-43. Fuses, test points for measuring regulated output voltages and voltage adjustment controls are located on the low voltage regulator assembly. Access to the assembly is obtained by removing the instrument rear panel. Each low voltage supply is fused. The fuses are in series with the regulator transistors, and all regulated output power flows through the fuse for the respective supply.

8-44. Since the +100V and −100V supplies are current fold-back limited, and the +15V and −12.6V supplies are current limited, an open fuse generally indicates that trouble exists in the regulator portion of the supply. If a fuse is open, check the series regulator transistor, driver transistor and comparator.

8-45. Troubleshooting the low voltage supply is facilitated by removing the power supply from the oscilloscope. This will provide access to the power transformer, rectifiers and filters. The procedure for removing the power supply module is explained later in this section of the manual.

WARNING

Lethal voltages are exposed when the power supply module is operated outside the oscilloscope mainframe.

8-46. The +100V supply should be checked first, since all other supplies use it as a reference. Unregulated operation of all of the other supplies may be the result of a defective +100V supply. Use the convenient test points to monitor the regulated output of a supply. If the +100V supply is defective, verify operation of the reference supply which is regulated by the 9-volt zener diode.

8-47. HIGH VOLTAGE POWER SUPPLY AND REGULATOR.

8-48. High voltage power supply problems are usually indicated by no display, a display that is too bright, an arcing sound, slow trace shift, blooming, or sudden shifts in display intensity. Regulator problems may result in no high voltage or excessive high voltage.

8-49. Check the waveform at the collector of the high voltage oscillator transistor if there is no high voltage. Normally, the oscillator output should be a 50-kHz sine wave. If only one high voltage is absent, check the appropriate rectifier and filter circuit. Refer to the troubleshooting tables if high voltage is present but not properly adjustable.

WARNING

The CRT post accelerator lead may have a high voltage present even if the instrument has been turned off for a long time. Ground both CRT and H.V. multiplier connections to discharge.

8-50. If no high voltage is present, check the H.V. oscillator supply voltage. An unregulated +27V furnishes oscillator operating power. The +27V power is fused, and the fuse is located on the H.V. oscillator assembly. With the high voltage multiplier disconnected, the oscillator frequency will increase if the circuit is operating properly.

8-51. The CRT cathode and grid high voltage leads can be disconnected by removing the CRT socket. This will further isolate the trouble. If it is determined that the H.V. multiplier is faulty, it must be replaced as a complete unit, since it is a sealed assembly.

8-52. DISASSEMBLY INFORMATION.

8-53. Many of the connections to etched circuit board assemblies are made by means of quick-disconnect connectors. This permits rapid removal of the assembly without unsoldering connections. Be sure to lift them off with a straight, direct pull.

8-54. If it is necessary to remove an assembly for servicing or replacement, the following information will provide guidance in accomplishing this in a manner to prevent damage and facilitate removal and replacement.

8-55. COVER REMOVAL.

8-56. Use a Posidrive type screwdriver for removing cover screws. (See Figure 8-2.)

Model 180C. Remove the covers as follows:

a. Ensure that LINE power switch is OFF and disconnect power plug from ac line source.

b. Remove four screws holding top cover from each side of instrument.

c. Remove top cover by opening bottom end and pulling away from instrument.

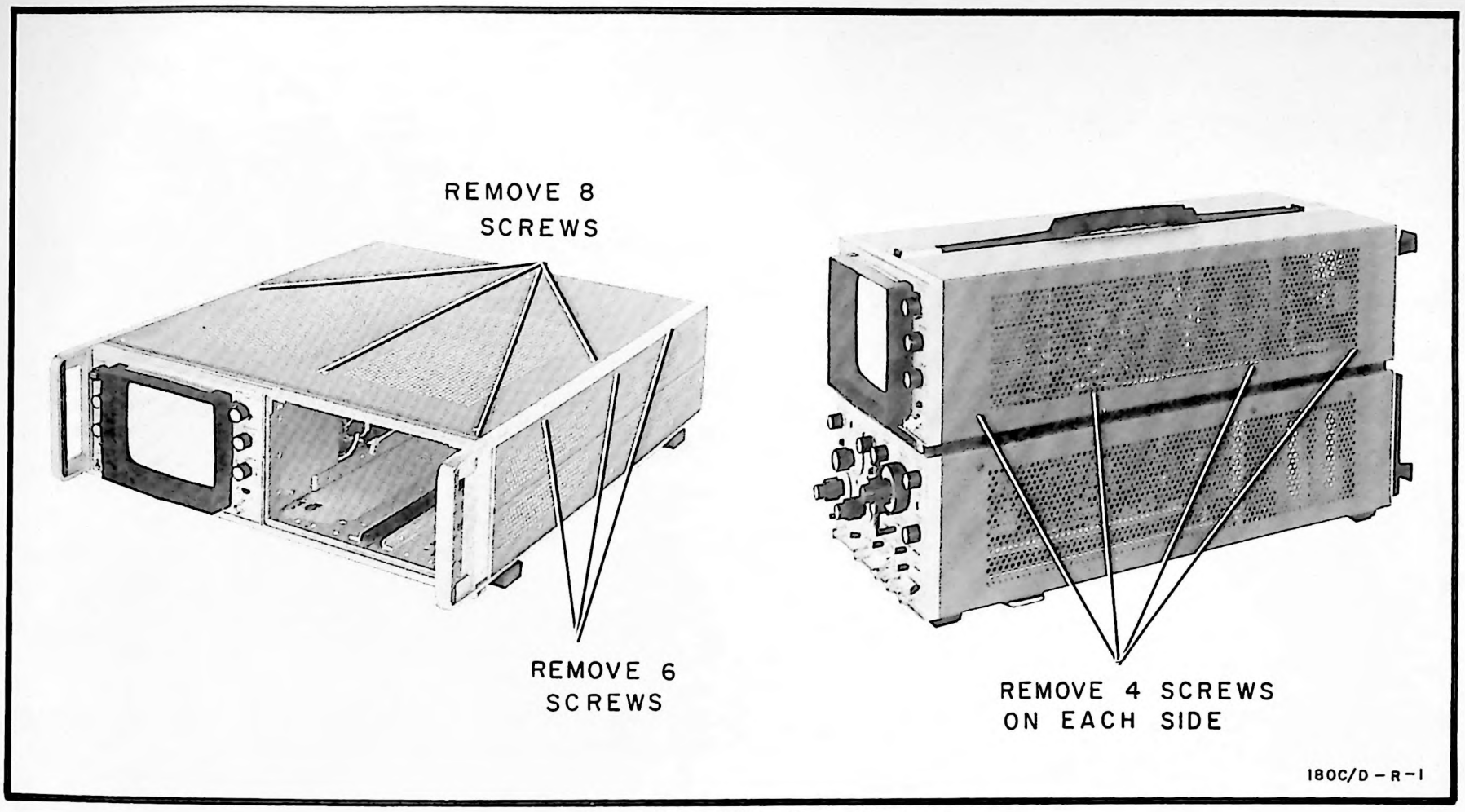


Figure 8-2. 180C/D Cover Removal

d. Remove rear access cover by releasing single quarter-turn fastener.

Model 180D. Remove the covers as follows:

a. Ensure that LINE power switch is OFF and disconnect power plug from ac line source.

b. Remove top cover, which is held in place with eight screws.

c. Remove both side covers. Each is held in place with six screws.

d. Remove rear access cover by releasing single quarter-turn fastener.

8-57. POWER MODULE REMOVAL.

8-58. The low voltage power supply module includes the power transformer, low voltage rectifier assembly, low voltage regulator assembly and the series regulators. The entire module is removable as a unit which can be further disassembled if desired. To facilitate servicing, the module may be simply disconnected and removed from the mainframe, or it may be operated outside the mainframe while connected to simplify troubleshooting.

8-59. To remove the power module, first disconnect the ac line power input. Then proceed as follows:

a. Remove bottom covers from Model 180C, or top and bottom covers from Model 180D.

b. Set instrument on rear end.

c. Remove four screws located on underside of power module.

d. Return instrument to horizontal position.

e. Model 180C: remove two nuts from screws extending into module from bottom feet. Model 180D: remove two screws from horizontal cross brace to power module.

f. Remove four rear screws. One screw is located near top and one near bottom of each series regulator heat sink. Model 180C: do not remove screws holding rear feet to heat sink.

g. Remove module by grasping filter capacitors on each side and pressing toward rear of instrument. Be careful not to pull module beyond length of connecting cable. Model 180C: lift module to clear screws before removing.

WARNING

Lethal voltages are exposed when the power supply module is operated outside the oscilloscope mainframe.

h. Disconnect two CRT filament leads (brown wires) and power connection jack before completely removing module.

8-60. CRT REMOVAL AND REPLACEMENT.

8-61. To remove the CRT, proceed as follows:

WARNING

To prevent personal injury, always wear a face mask or safety goggles when handling the CRT. Wear protective gloves and handle carefully.

a. Disconnect ac power input and remove plug-ins.

b. Remove all four covers from Model 180C or top and bottom covers from Model 180D.

c. Model 180D: remove shield (two screws) next to CRT post accelerator lead. Shield is between CRT and plug-in compartment.

WARNING

The CRT post accelerator lead may have a high voltage present even if the instrument has been turned off for a long time. Ground both CRT and H.V. multiplier connection to discharge.

d. Use grounded screwdriver and carefully lift insulator cap. Ground spring wire clip as lead is loosened from CRT.

e. Remove post accelerator lead from CRT. Lead is held in place by spring wire clip. To remove it from CRT, compress clip by pressing against one side of spring wire with screwdriver blade while gently lifting same side of insulator cap.

f. Remove connections from CRT neck pins. Use long-nose pliers through access holes in CRT shield and brackets. There are nine connections.

g. Squeeze plastic light shield at midpoint on top and on bottom, and remove it.

h. Remove four screws holding metal bezel on front panel.

i. Carefully loosen and pry socket from CRT base.

j. Loosen clamp at rear of CRT.

k. Place one hand on CRT face. With other hand, slide CRT forward and out of instrument. Be careful not to damage CRT neck pin connections.

l. Before replacing CRT, carefully clean the area of the H.V. post accelerator connection. Use a mild solution of detergent and water or freon degreaser. Carefully dry the area completely.

m. Gently clean any oxidation from neck pins, being careful to not bend pins or scratch glass.

n. To replace CRT, reverse above procedure. Before tightening clamp, align CRT to place graticule lines square with oscilloscope frame.

Note

If the standard P31 phosphor CRT is replaced with a P11 phosphor CRT, circuit modification is required. The increase in intensity from use of the FIND BEAM switch can cause phosphor burn. Refer to Section VII for information about the circuit change required.

8-62. After replacing CRT, check the following adjustments: Intensity Limit, Flood Gun, Trace Alignment, Horizontal Amplifier, Astigmatism, Vernier Balance, Gain and Horizontal Linearity.

8-63. HIGH VOLTAGE SUPPLY REPLACEMENT.

8-64. The following procedure should be used when replacing the high voltage rectifier assembly, high voltage multiplier assembly or high voltage oscillator assembly.

a. Remove Model 180C left top cover or Model 180D left side and rear covers.

b. Remove cover to high voltage compartment (two screws).

c. Unsolder five wires connecting H.V. rectifier transformer circuit board and H.V. oscillator assembly.

d. Unsolder white (9) wire from A5CR2 and gray (8) wire from transformer circuit board.

e. Remove four screws from corners of H.V. rectifier assembly.

f. Remove H.V. rectifier assembly from compartment of H.V. multiplier assembly.

g. Unsolder white (9) wire, orange (3) wire and blue (6) wire from H.V. rectifier assembly.

h. Remove two screws holding H.V. oscillator circuit board.

i. From top of instrument, remove one screw holding H.V. oscillator transistor to mounting bracket. (Two mica insulating washers are between transistor and mounting bracket.) This step may be omitted and transistor left mounted if desired. If left in place, exercise care to properly seat transistor in socket when replacing board.

j. Disconnect three square-pin connectors from underside of circuit board, and remove circuit board.

k. H.V. multiplier assembly is also free and can be removed from supporting bracket.

Table 8-1. Schematic Notes

Refer to MIL-STD -15-1A for schematic symbols not listed in this table.

= Etched circuit board

= Front-panel marking

= Rear-panel marking

= Front-panel control

= Screwdriver adjustment

P/O = Part of

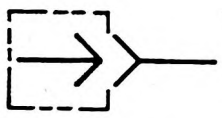
CW = Clockwise end of variable resistor

NC = No connection

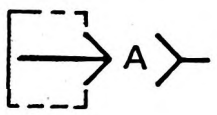


= Waveform test point (with number)

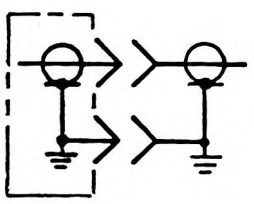
= Common electrical point (with letter) not necessarily ground



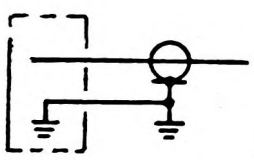
= Single-pin connector on board



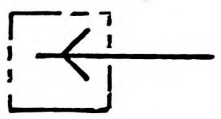
= Pin of a plug-in board (with letter or number)



= Coaxial cable connected to snap-on jack



= Coaxial cable connected directly to board



= Wire connected to pressure-fit socket on board

= Main signal path

= Primary feedback path

= Secondary feedback path



= Field-effect transistor (P-type base)



= Field-effect transistor (N-type base)



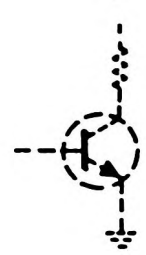
= Breakdown diode (voltage regulator)



= Tunnel diode



= Step-recovery diode



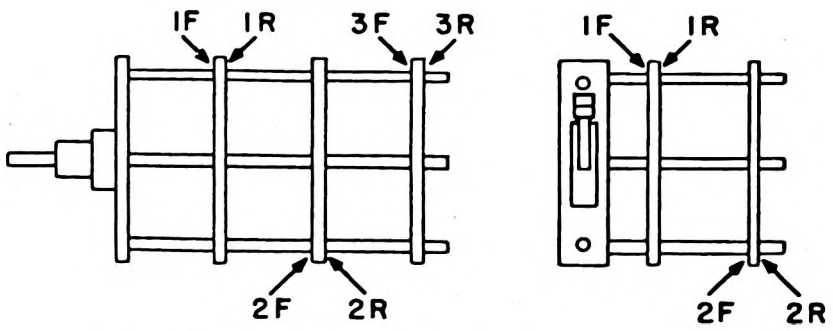
= Circuits or components drawn with dashed lines (phantom) show function only and are not intended to be complete. The circuit or component is shown in detail on another schematic.

(925) = Wire colors are given by numbers in parentheses using the resistor color code

[(925) is wht-red-grn]

0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

Switch wafers are identified as follows:



* = Optimum value selected at factory, typical value shown; part may have been omitted.

Unless otherwise indicated:
resistance in ohms
capacitance in picofarads
inductance in microhenries

Table 8-2. Miscellaneous Troubleshooting Tips

Symptom	Suggested Checks
Intermittent deflection.	Check for loose or corroded connections to CRT neck pins. Check for intermittent open in deflection leads.
Intensity variation causes trace shift (either axis).	Check for open deflection lead in axis affected. If trouble is in vertical axis, check vertical plug-in connector and mating connector in oscilloscope.
No output from Gate or Sweep output jacks.	Check emitter-follower for output affected. Check circuit interconnections (cables, connectors).
Improper Z-axis modulation.	Check normal operation with plug-ins installed. If OK, check connections and check inputs.
CRT trace develops distortion over long period.	Instrument may have been subjected to high magnetic field, magnetizing CRT elements. Possible CRT malfunction.
Improper deflection.	If symptom is apparent in both vertical and horizontal axes, check high voltage. If H.V. is low, expanded display results. If H.V. is high, causes contracted display. Vertical axis only: check vertical plug-in, deflection leads and connectors. Horizontal axis only: check with replacement time base plug-in. If OK, problem is in time base plug-in. Otherwise check oscilloscope horizontal amplifier, deflection leads and connectors.

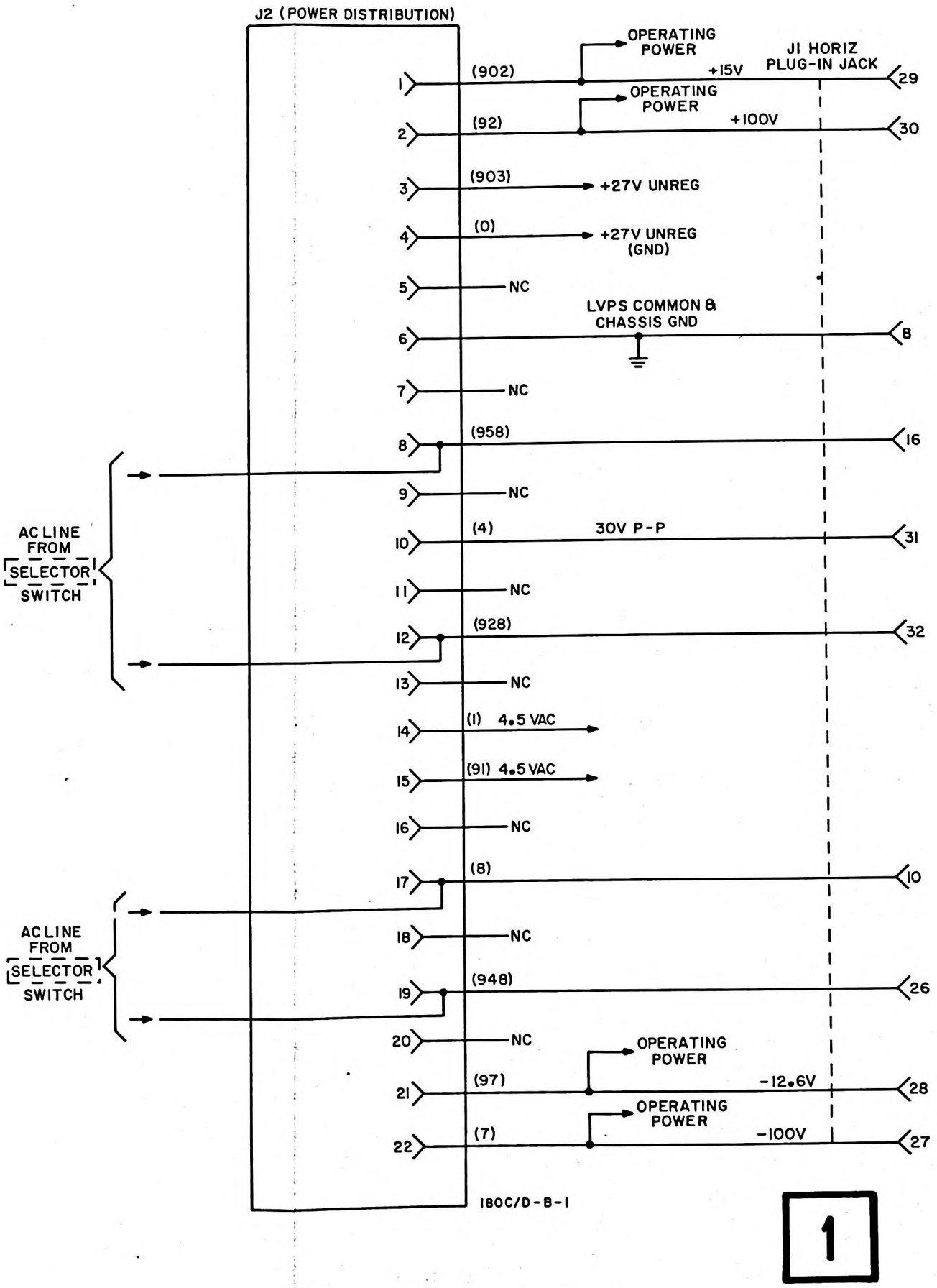
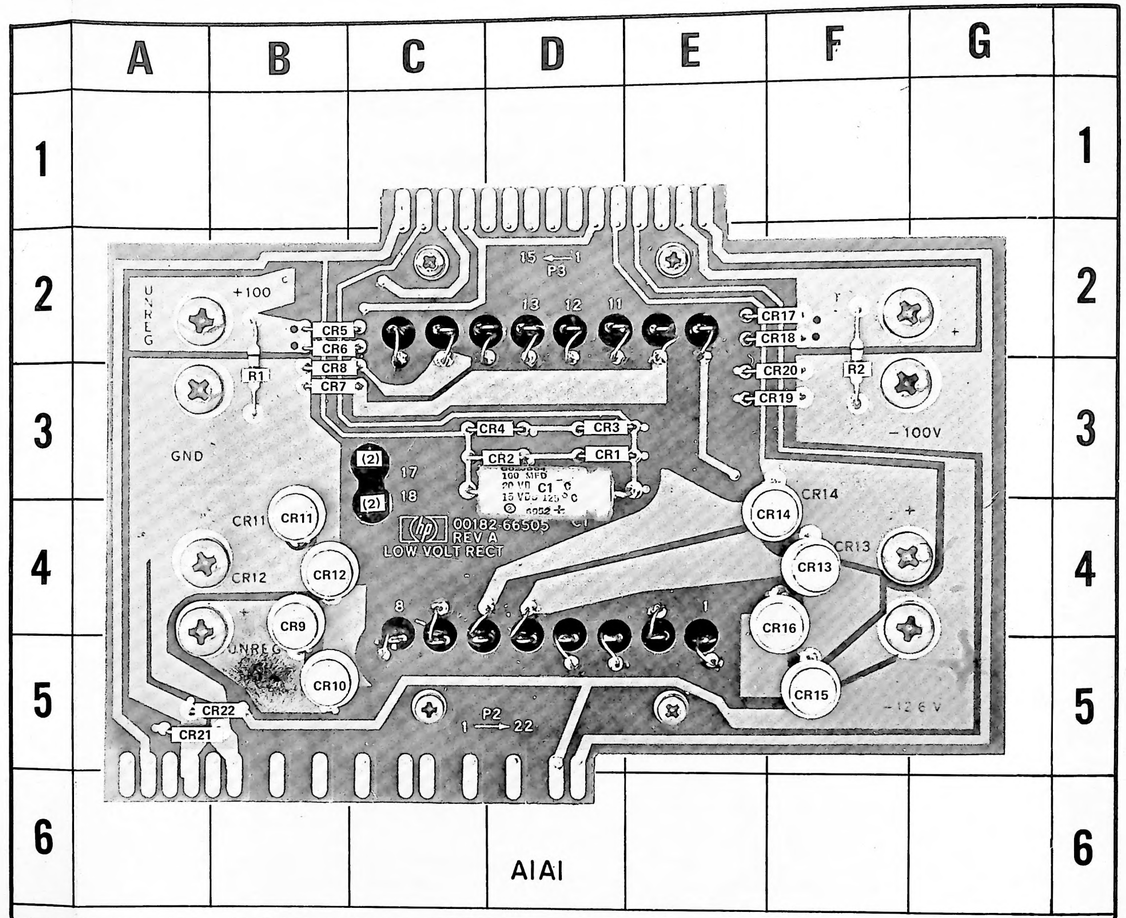


Figure 8-3.
Low Voltage Power Connections



Note: Circuit boards have plated through component holes. This permits soldering from either side of the board.

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D-3	CR5	B-2	CR10	B-5	CR15	F-5	CR20	F-3
CR1	D-3	CR6	B-2	CR11	B-4	CR16	F-4	CR21	A-5
CR2	D-3	CR7	B-3	CR12	B-4	CR17	F-2	CR22	B-5
CR3	D-3	CR8	B-3	CR13	F-4	CR18	F-2	R1	B-3
CR4	D-3	CR9	B-4	CR14	F-4	CR19	F-3	R2	F-3

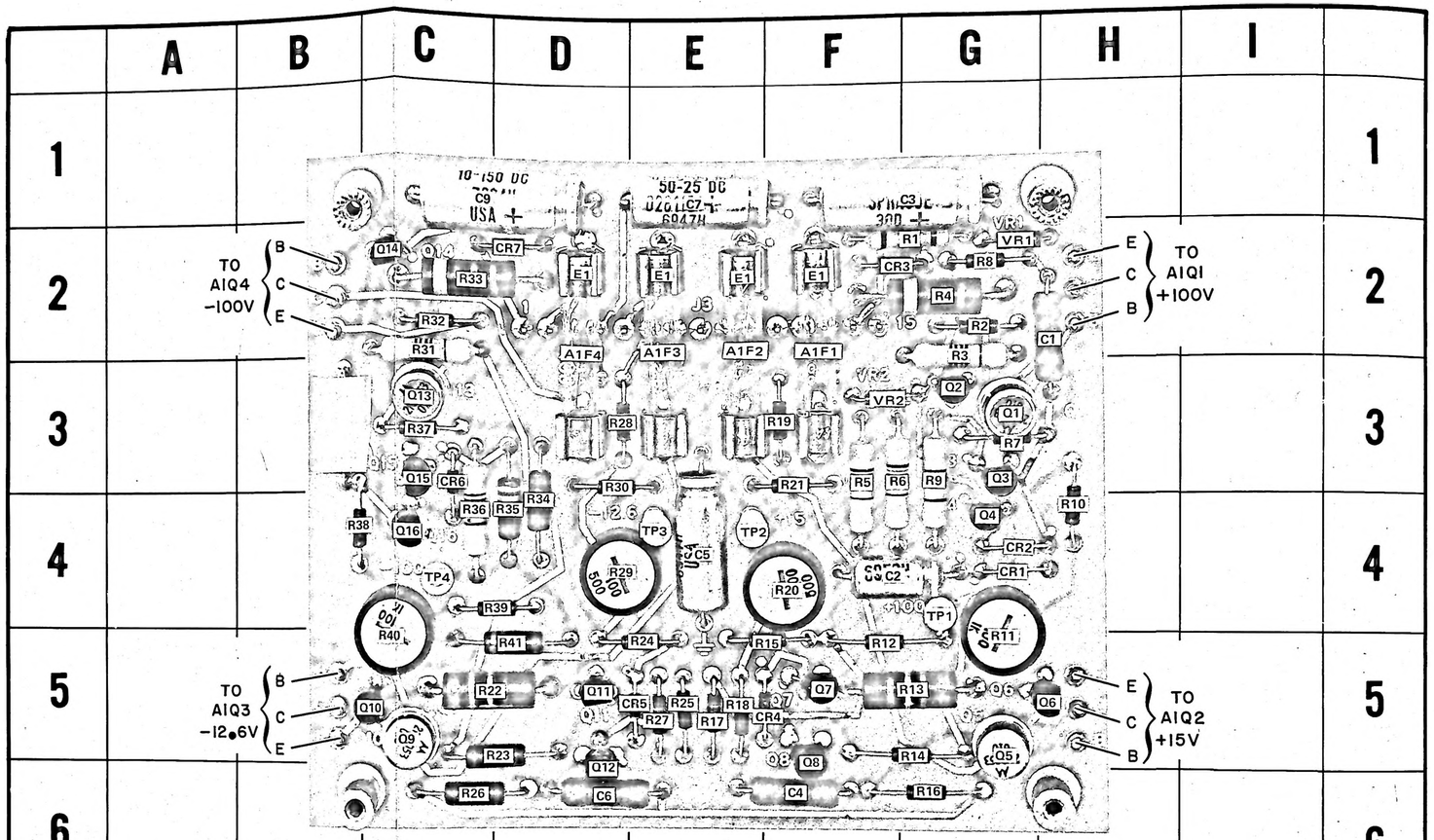
182A-8-6

Figure 8-4. Low Voltage Rectifier Component Identification

Table 8-3. Low Voltage Power Supply Troubleshooting Tips

Symptom	Suggested Checks
All supplies low or high and unregulated.	Check ac input line voltage and position of rear-panel SELECTOR switch (115 or 230V) *Check +100V supply and A1A2VR2. (+100V supply is used as reference for −100V, +15V, −12.6V supplies and A1A2VR2 provides reference voltage for +100V supply).
One supply high and unregulated with high ripple.	Check comparator and series regulator.
One supply low.	Check for excessive current drain. *Check comparator.
No output from one supply.	Check fuse. Check regulator. (Supplies are current limited. Fuse will not open due to shorted load.)
Open line fuse.	Check ac line voltage and position of rear-panel SELECTOR switch. *Check rectifier diodes. Check filter capacitors. Check power transformer.

* Most common fault.



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
A1F1	F-2	C1	H-2	CR4	E-5	Q5	G-5	R1	G-2	R13	G-5	R25	E-5	R37	C-3		
A1F2	E-2	C2	F-4	CR5	E-5	Q6	H-5	R2	G-2	R14	G-5	R26	C-6	R38	B-4		
A1F3	E-2	C3	G-1	CR6	C-3	Q7	F-5	R3	G-2	R15	F-5	R27	E-5	R39	D-4		
A1F4	D-2	C4	F-6	CR7	D-2	Q8	F-5	R4	G-2	R16	G-6	R28	D-3	R40	C-5		
		C5	E-4	E1	D-2	Q9	C-5	R5	F-3	R17	E-5	R29	D-4	R41	D-5		
		C6	D-6	E1	E-2	Q10	C-5	R6	F-3	R18	E-5	R30	D-3	TP1	G-4		
		C7	E-1	E1	E-2	Q11	D-5	R7	G-3	R19	F-3	R31	C-2	TP2	E-4		
		C9	D-1	E1	F-2	Q12	D-6	R8	G-2	R20	F-4	R32	C-2	TP3	E-4		
		CR1	G-4	Q1	G-3	Q13	C-3	R9	G-3	R21	F-3	R33	C-2	TP4	C-4		
		CR2	G-4	Q2	G-3	Q14	C-2	R10	H-4	R22	C-5	R34	D-4	VR1	G-2		
		CR3	F-2	Q3	G-3	Q15	C-3	R11	G-5	R23	D-5	R35	D-4	VR2	F-3		
				Q4	G-4	Q16	C-4	R12	F-5	R24	E-5	R36	C-4				

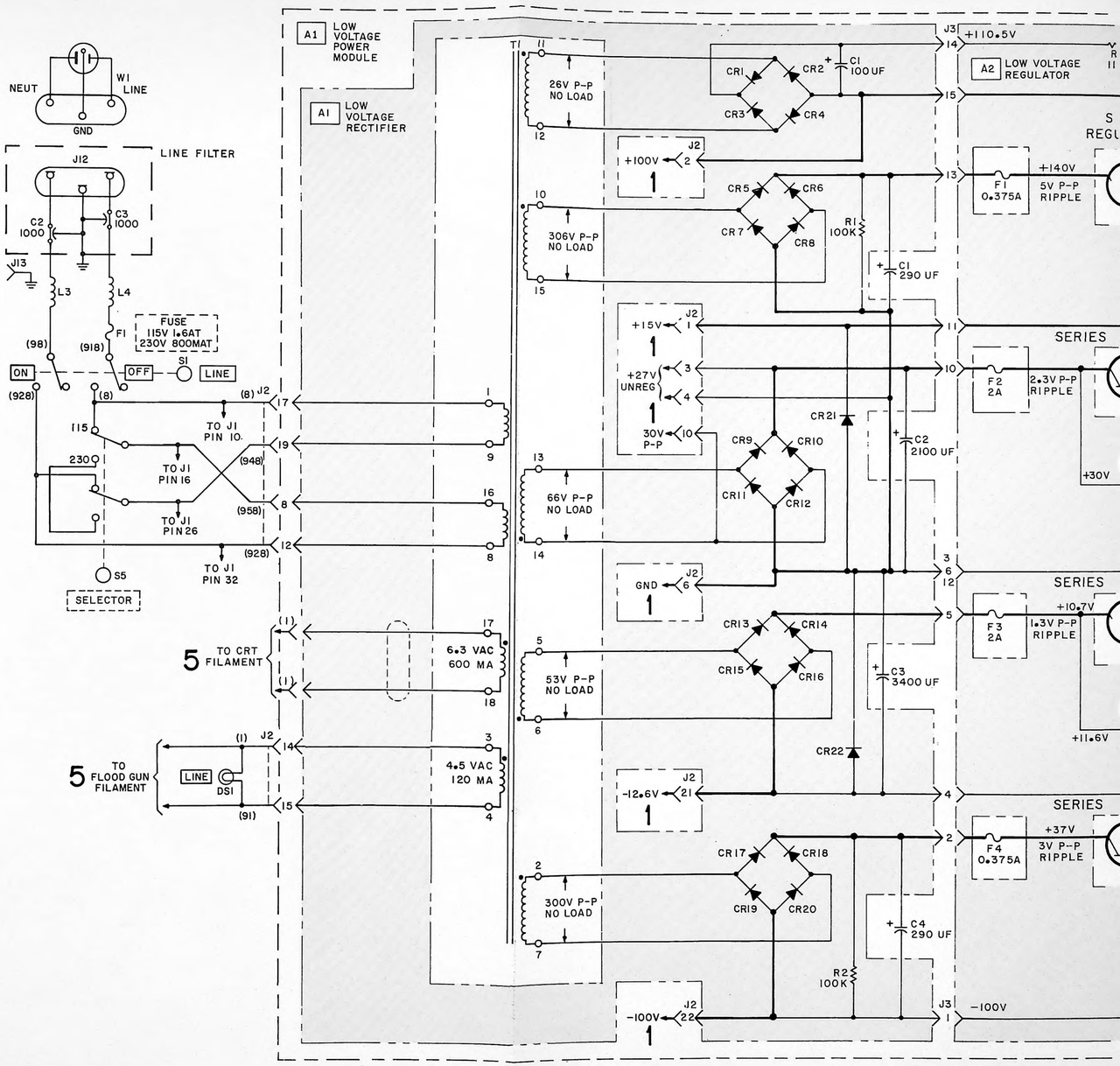
Etched circuit boards have plated-through component holes. This permits soldering from either side of the board.

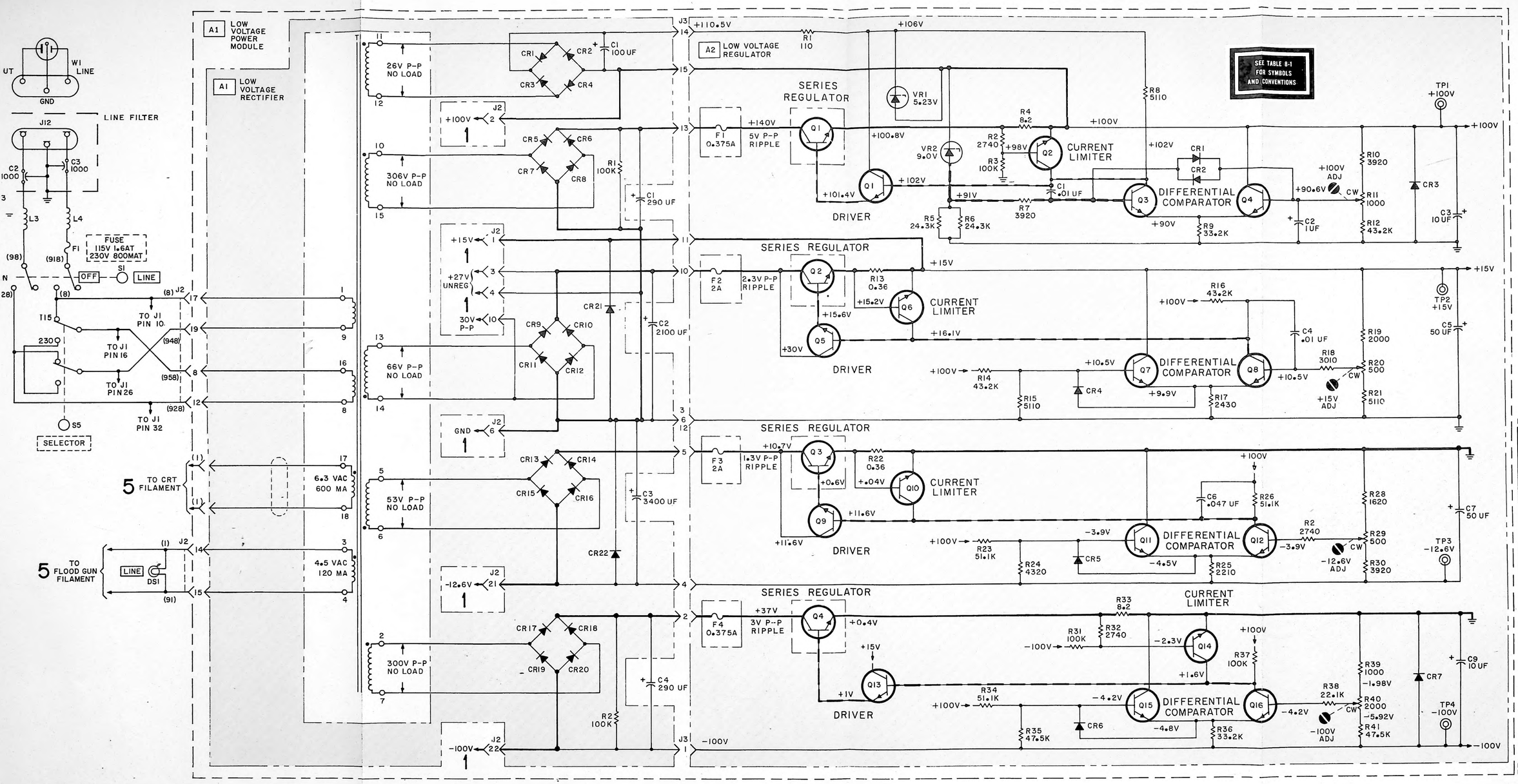
182A-8-4

Figure 8-5. Low Voltage Regulator Component Identification

Table 8-4. Low Voltage Power Supply Voltage Measurement Conditions

1. Plug-ins not installed.
2. LINE power ON.
3. Line voltage 115V or 230V ac.
4. All dc voltages are referenced to ground. Use chassis ground or soldering lug ground located on LV Rectifier board.
5. All dc voltages measured with HP Model 414A Auto Voltmeter (100 MΩ input impedance).





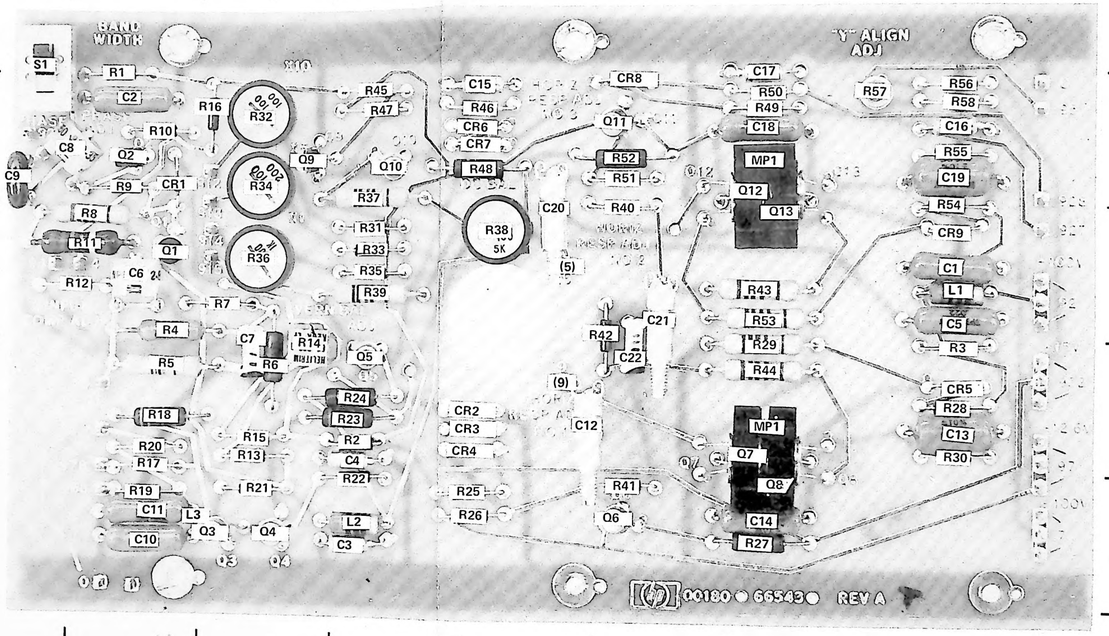
REFERENCE DESIGNATIONS

A1	CHASSIS
C1-4 F1-4 Q1-4 T1	C2,3 DS1 F1 J2,12,13 L3,4 S1,5 W1
A1A1	**A1A2**
C1 CR1-22 J2 R1,2	C1-7,9 CR1-7 J3 Q1-16 R1-41 TP1-4 VR1,2

DELETED A1A2C8

180C/D-LVPS-1125A
180C/D-E-1

Figure 8-6.
Low Voltage Power Supply Schematic



Circuit boards have plated through component holes. This permits soldering from either side of the board.

A 2

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	J-3	C15	G-2	CR7	G-2	Q8	I-5	R8	D-3	R21	E-5	R34	E-2	R47	F-2		
C2	D-2	C16	J-2	CR8	H-2	Q9	E-2	R9	D-2	R22	F-5	R35	F-3	R48	G-2		
C3	F-5	C17	I-1	CR9	J-3	Q10	F-2	R10	D-2	R23	F-4	R36	E-3	R49	I-2		
C4	F-4	C18	I-2	L1	J-3	Q11	H-2	R11	D-3	R24	F-4	R37	F-2	R50	I-2		
C5	J-3	C19	J-2	L2	F-5	Q12	I-2	R12	D-3	R25	G-5	R38	G-3	R51	H-2		
C6	D-3	C20	G-3	L3	D-5	Q13	I-3	R13	E-4	R26	G-5	R39	F-3	R52	H-2		
C7	E-4	C21	H-3	MP1	I-2	R1	D-1	R14	E-4	R27	I-5	R40	H-3	R53	I-3		
C8	D-2	C22	H-4	Q1	D-3	R2	F-4	R15	E-4	R28	J-4	R41	H-5	R54	J-2		
C9	C-2	CR1	D-2	Q2	D-2	R3	J-4	R16	E-2	R29	I-4	R42	H-3	R55	J-2		
C10	D-5	CR2	G-4	Q3	E-5	R4	D-3	R17	D-4	R30	J-4	R43	I-3	R56	J-2		
C11	D-5	CR3	G-4	Q4	E-5	R5	D-4	R18	D-4	R31	F-3	R44	I-4	R57	J-2		
C12	G-4	CR4	G-4	Q5	F-4	R6	E-4	R19	D-5	R32	E-2	R45	F-2	R58	J-2		
C13	J-4	CR5	J-4	Q6	H-5	R7	E-3	R20	D-4	R33	F-3	R46	G-2	S1	C-1		
C14	I-5	CR6	G-2	Q7	I-4												

180C/D-R-10

Figure 8-7. Horizontal Amplifier Component Identification

Table 8-5. Horizontal Amplifier Voltage Measurement Conditions

1. Plug-ins not installed.

2. LINE power ON.

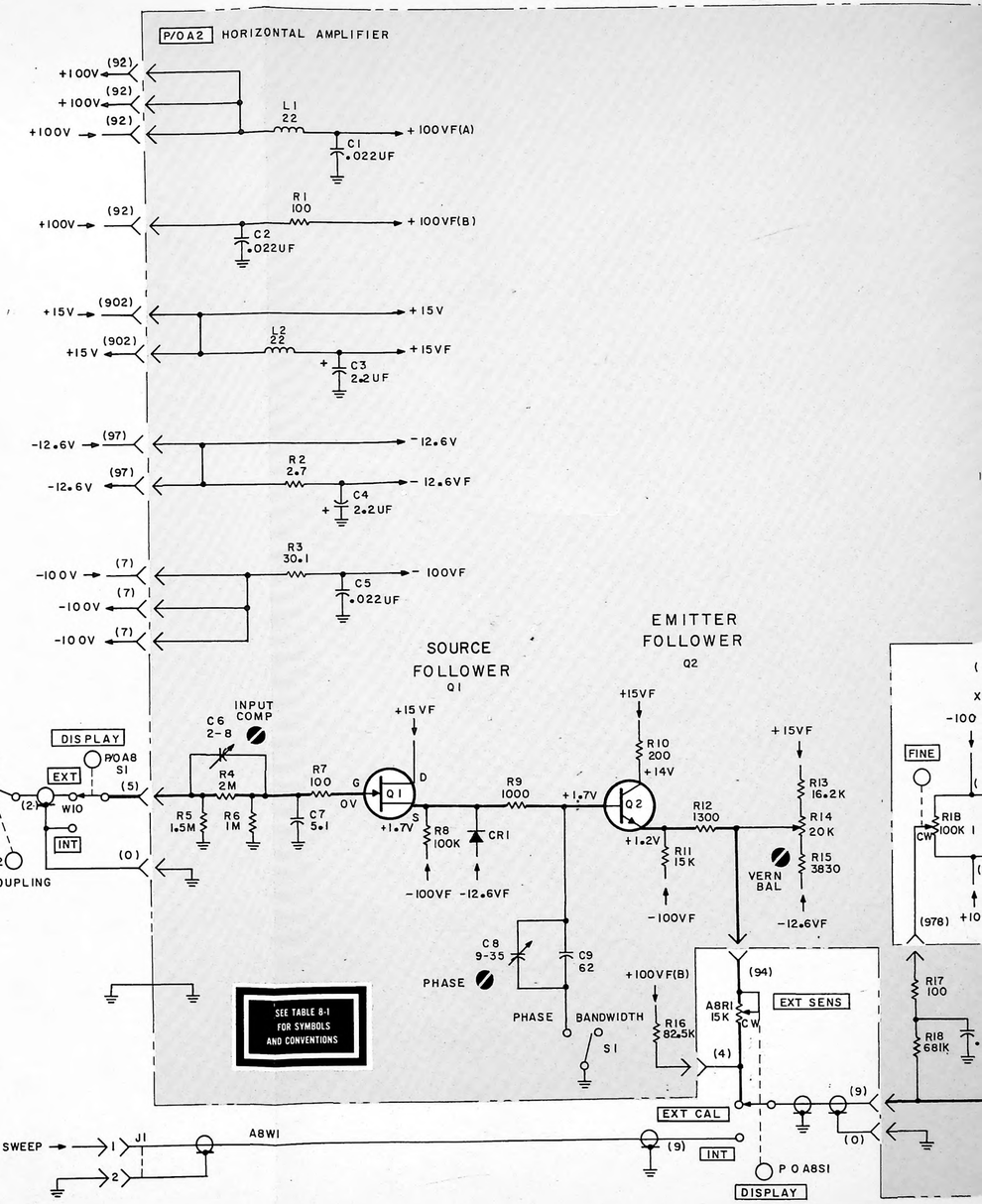
3. No signal input.

4. Set controls as follows:

INTENSITY	fully ccw
SCALE	OFF
FOCUS	fully ccw
POSITION	centered
DISPLAY	EXT CAL
MAGNIFIER	X1

5. All voltages referenced to ground.

6. All voltages measured with HP Model 414A Auto Voltmeter (100 MΩ input impedance).



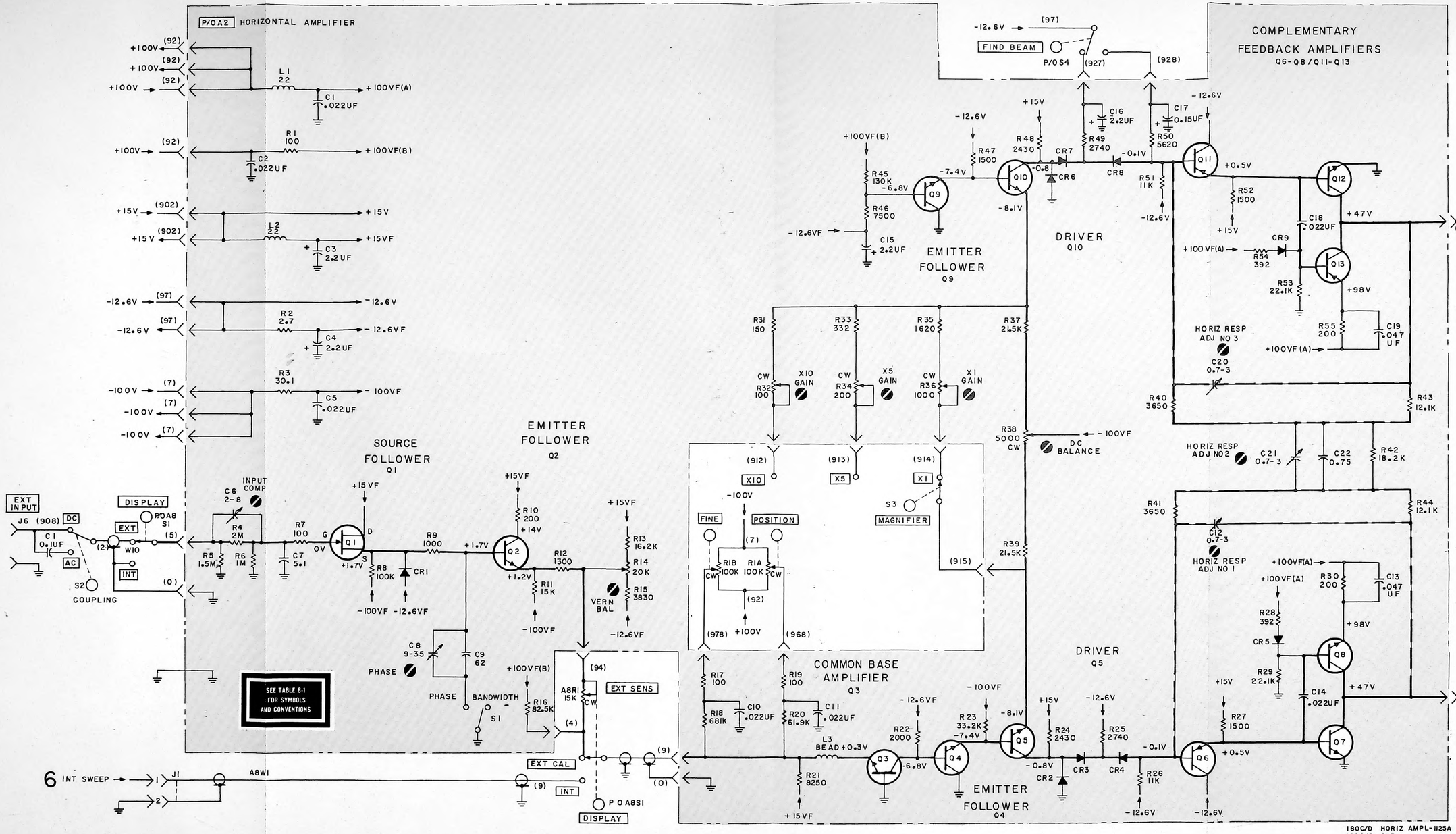
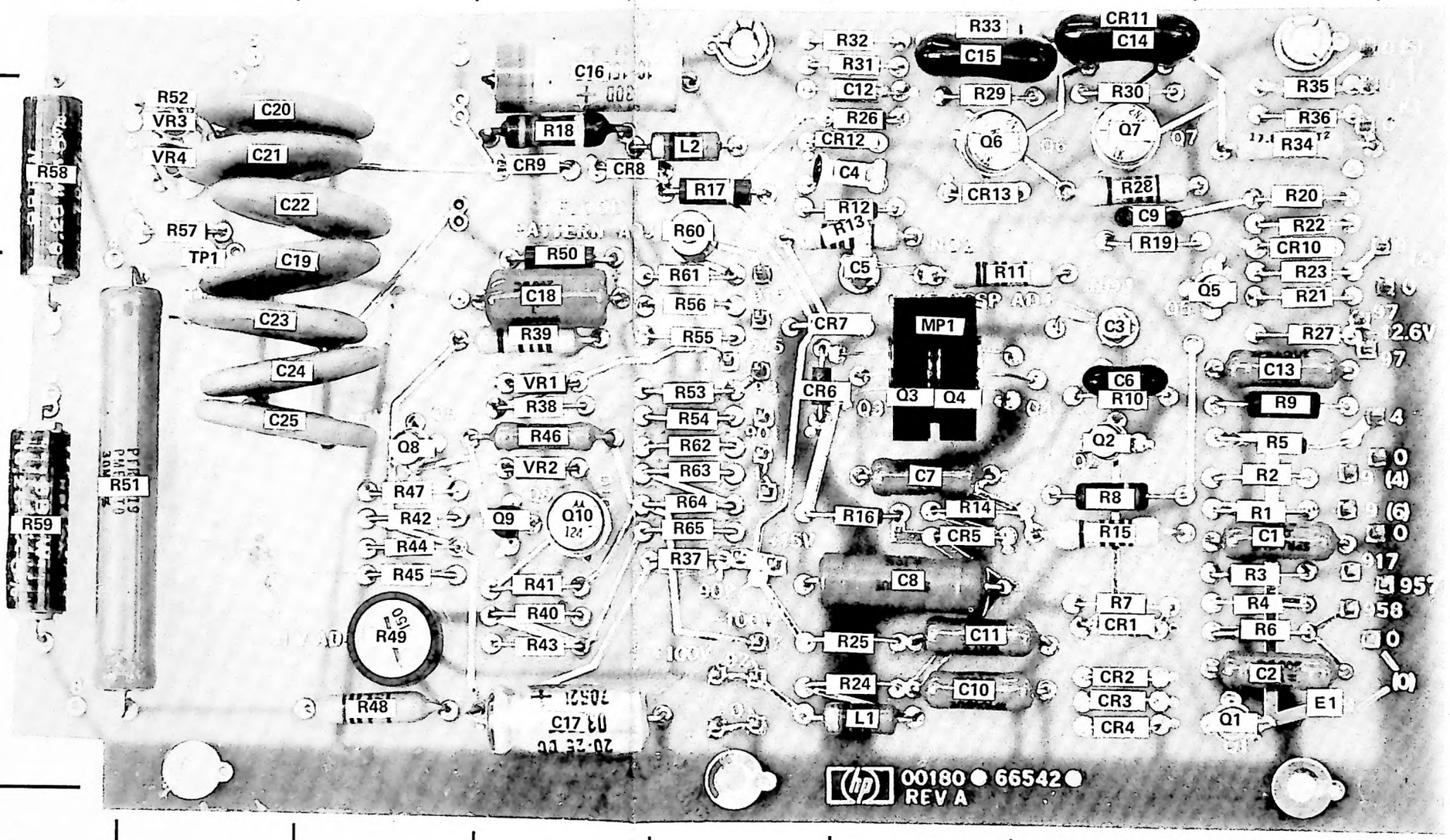


Figure 8-8.
Horizontal Amplifier Schematic

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1														1
2														2
3														3
4														4
5														5
6														6



Circuit boards have plated through component holes. This permits soldering from either side of the board.

A3

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	J-4	C17	F-5	CR8	F-2	Q6	H-2	R11	H-3	R26	H-2	R41	F-4	R56	G-3
C2	J-5	C18	F-3	CR9	F-2	Q7	I-2	R12	H-2	R27	J-3	R42	E-4	R57	D-2
C3	I-3	C19	D-3	CR10	J-2	Q8	E-4	R13	H-2	R28	I-2	R43	F-5	R58	C-2
C4	H-2	C20	D-2	CR11	I-1	Q9	F-4	R14	H-4	R29	H-2	R44	E-4	R59	C-4
C5	H-3	C21	D-2	CR12	H-2	Q10	F-4	R15	I-4	R30	I-2	R45	E-4	R60	G-2
C6	I-3	C22	D-2	CR13	H-2	R1	J-4	R16	H-4	R31	H-1	R46	F-3	R61	G-3
C7	H-4	C23	D-3	E1	J-5	R2	J-4	R17	G-2	R32	H-1	R47	E-4	R62	G-4
C8	H-4	C24	D-3	L1	H-5	R3	J-4	R18	F-2	R33	H-1	R48	E-5	R63	G-4
C9	I-2	C25	D-3	L2	G-2	R4	J-4	R19	I-2	R34	J-2	R49	E-5	R64	G-4
C10	H-5	CR1	I-5	MP1	H-3	R5	J-4	R20	J-2	R35	J-2	R50	F-3	R65	G-4
C11	H-5	CR2	I-5	Q1	J-5	R6	J-5	R21	J-3	R36	J-2	R51	D-4	TP1	D-3
C12	H-2	CR3	I-5	Q2	I-4	R7	I-4	R22	J-2	R37	G-4	R52	D-2	VR1	F-3
C13	J-3	CR4	I-5	Q3	H-3	R8	I-4	R23	J-3	R38	F-3	R53	G-3	VR2	F-4
C14	I-1	CR5	H-4	Q4	H-3	R9	J-3	R24	H-5	R39	F-3	R54	G-3	VR3	D-2
C15	H-1	CR6	G-3	Q5	J-3	R10	I-3	R25	H-5	R40	F-4	R55	G-3	VR4	D-2

180C/D-R-8

Figure 8-9. Gate Amplifier Component Identification

Table 8-6. Gate Amplifier and H.V. Regulator Voltage Measurement Conditions

1. Plug-ins not installed.
2. LINE power ON.
3. No signal input.
4. Set controls as follows:

INTENSITY	fully ccw
SCALE	OFF
FOCUS	fully ccw
POSITION	centered
DISPLAY	EXT CAL
MAGNIFIER	X1

5. All voltages referenced to ground.
6. All voltages measured with HP Model 414A Auto Voltmeter (100 MΩ input impedance).

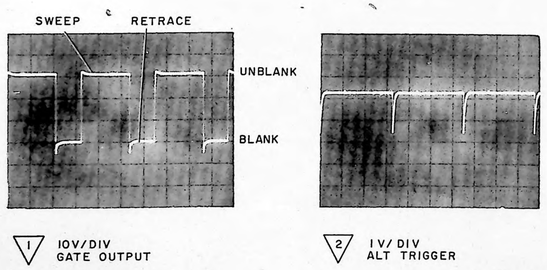
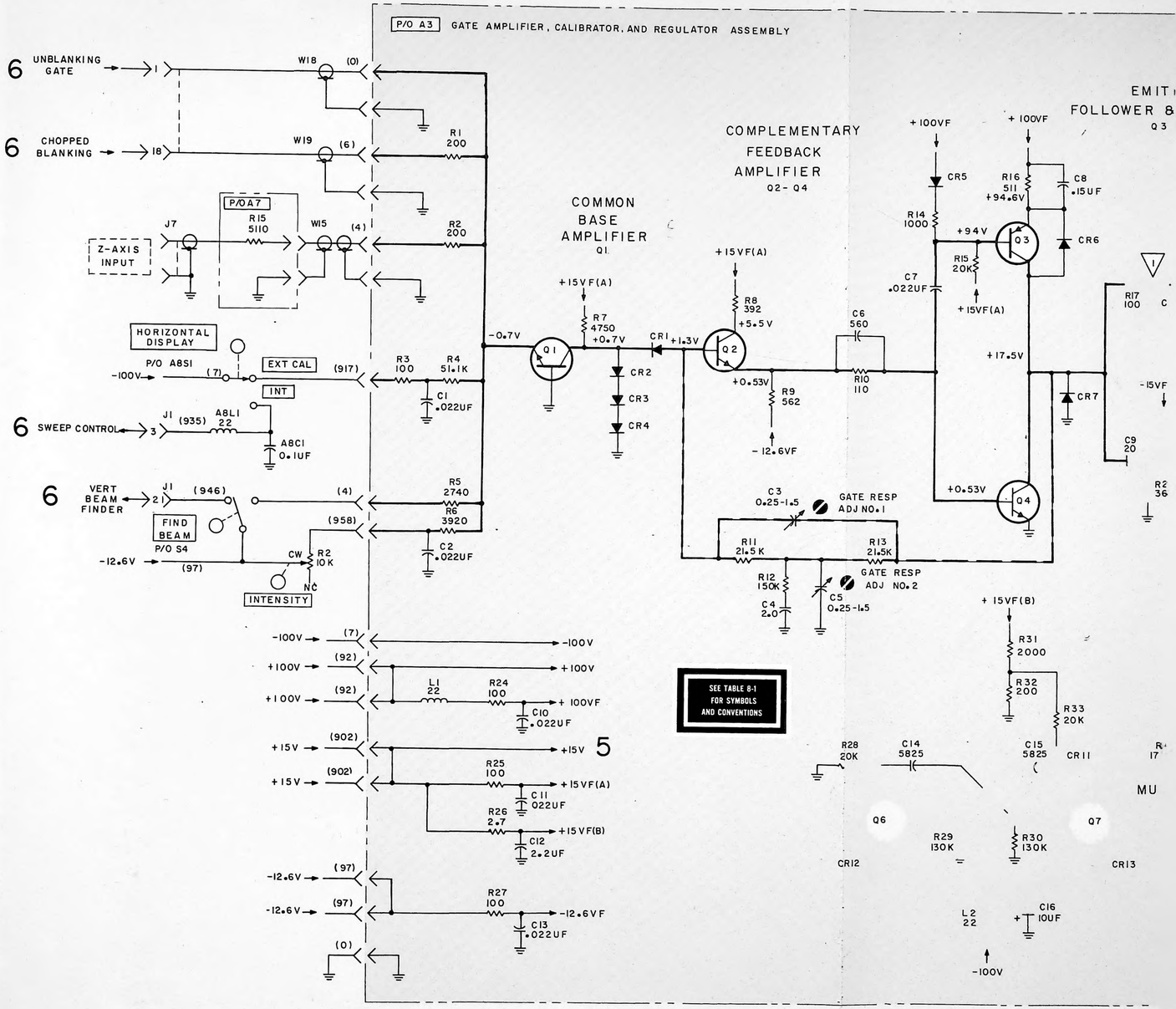


Figure 8-10. Gate Amplifier Waveforms



Conditions

ccw
OFF
ccw
ered
CAL
X1

eter

C/D-A-11

P/O A3 GATE AMPLIFIER, CALIBRATOR, AND REGULATOR ASSEMBLY

6 UNBLANKING GATE → J1 pin 1 — W18 (0)
6 CHOPPED BLANKING → J1 pin 18 — W19 (6)
R1 200
P/O A7 — R15 5110 — W15 (4) — R2 200
J7 Z-AXIS INPUT
HORIZONTAL DISPLAY
P/O A8S1 -100V (7) EXT CAL (917) INT
R3 100 — R4 51.1K — C1 .022UF
6 SWEEP CONTROL → J1 pin 3 (935) A8L1 22 — A8C1 0.1UF
6 VERT BEAM FINDER → J1 pin 21 (946) FIND BEAM P/O S4 (4) (958) (97) -12.6V
R5 2740 — R6 3920 — C2 .022UF
R2 10K CW NC INTENSITY

-100V (7) → -100V
+100V (92) → +100V
+100V (92) → L1 22 — R24 100 → +100VF — C10 .022UF
+15V (902) → +15V 5
+15V (902) → R25 100 → +15VF(A) — C11 022UF
R26 2.7 → +15VF(B) — C12 2.2UF
-12.6V (97) → R27 100 → -12.6VF — C13 .022UF
-12.6V (97)
(0)

COMMON BASE AMPLIFIER Q1

+15VF(A) — R7 4750 — +0.7V — -0.7V — Q1
CR1 +1.3V — CR2 — CR3 — CR4

COMPLEMENTARY FEEDBACK AMPLIFIER Q2-Q4

+15VF(A) — R8 392 — +5.5V — Q2
+0.53V — R9 562 — -12.6VF
C6 560 — R10 110

C3 0.25-1.5 GATE RESP ADJ NO.1
R11 21.5K — R13 21.5K
R12 150K — C4 2.0 — C5 0.25-1.5 GATE RESP ADJ NO.2

+100VF — CR5 — R14 1000 — +94V — Q3
+100VF — R16 511 +94.6V — C8 .15UF — CR6
R15 20K — +15VF(A)
C7 .022UF
+17.5V — CR7
+0.53V — Q4

EMITTER FOLLOWER & CLIPPER Q3

-100V — R18 68K — CR9 — UNBLANKING SIGNAL 5
R17 100 — CR8

-15VF(A) — R19 8250 +4.1V — C9 20 — R20 3650
-12.6VF — R21 5110 — -10.6V — Q5
0V — CR10 — R23 825
R22 2000

0V -1.5V — W17 J1 (2) 6 → ALT TRIG 1

+15VF(B) — R31 2000 — R32 200 — R33 20K
R28 20K — C14 5825 — C15 5825 — CR11 — R34 17.82K
Q6 — Q7
R29 130K — R30 130K
CR12 — CR13
L2 22 — C16 10UF
-100V

MULTIVIBRATOR Q6/Q7

R35 50 — (0) — 0V
R36 1950 — (9) — J4 CALIBRATOR 250 MV
W20
(0) — J3 10V
J5 GND

SEE TABLE 8-1 FOR SYMBOLS AND CONVENTIONS

Reference designations within assemblies are abbreviated. Add assembly designation as prefix to form complete designation (e.g., R1 on assembly A2 is A2R1).

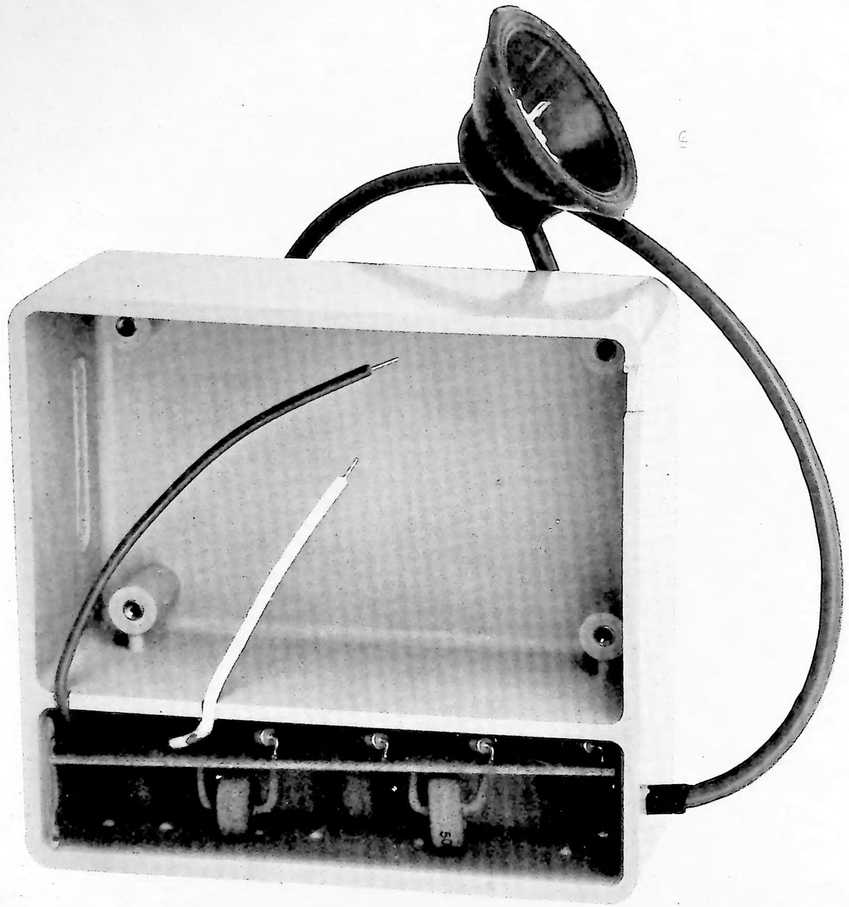
P/O A3	P/O A7	CHASSIS
C1-16 CR1-13 L1, 2 Q1-7 R1-36	R15	P/O J1, 3-5, 7 R2 P/O S4 W15, 17-20
	P/O A8	
	C1 L1 P/O S1	

4

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180C/D-GATE-AMPL. 1125A
180C/D-D-1

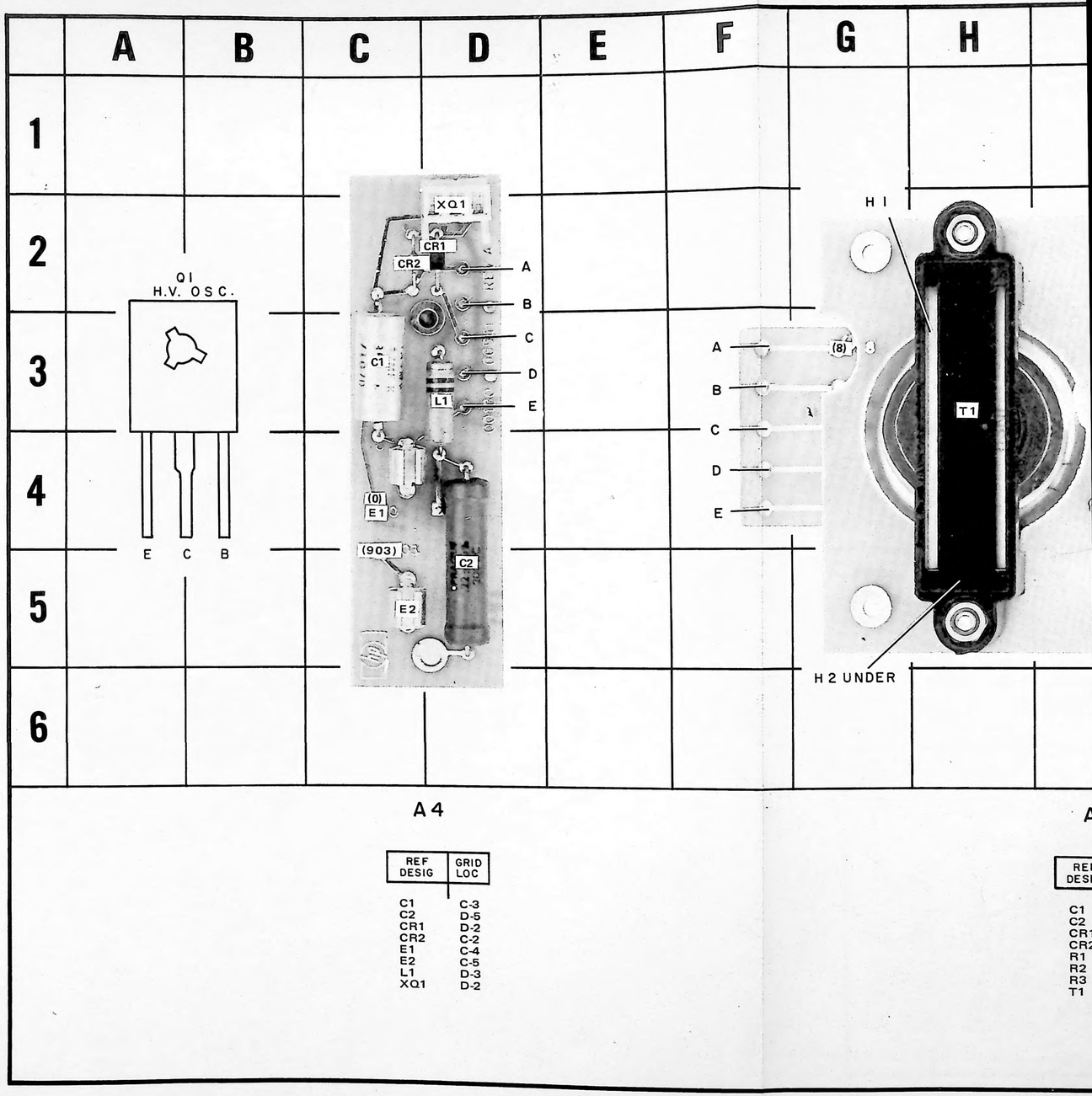
Figure 8-11.
Gate Amplifier and Calibrator Schematic



A6

180C/D-5

Figure 8-12. H.V. Multiplier



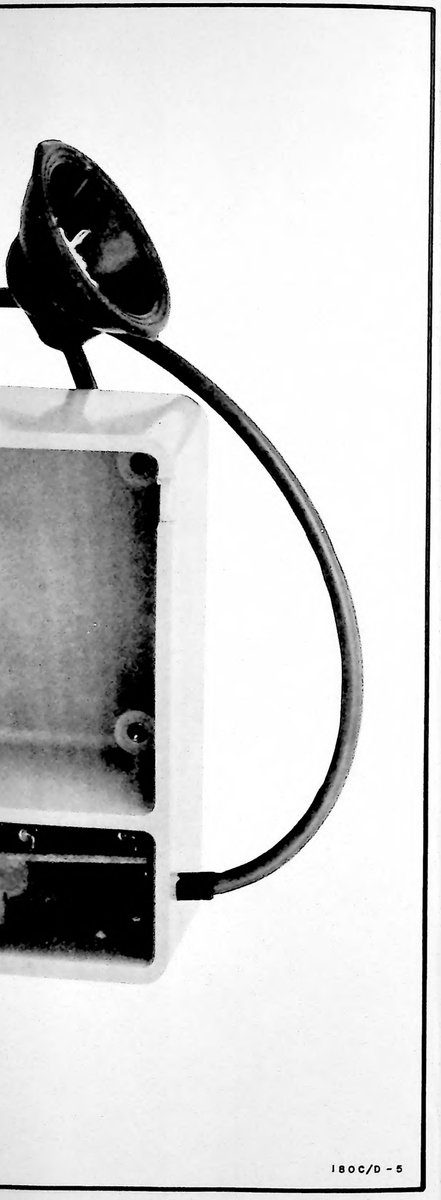
A4

REF DESIG	GRID LOC
C1	C-3
C2	D-5
CR1	D-2
CR2	C-2
E1	C-4
E2	C-5
L1	D-3
XQ1	D-2

A

REF DESIG	GRID LOC
C1	
C2	
CR1	
CR2	
R1	
R2	
R3	
T1	

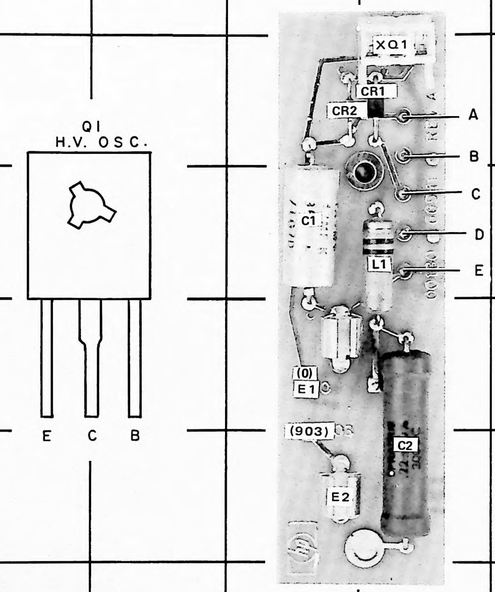
Figure



180C/D-5

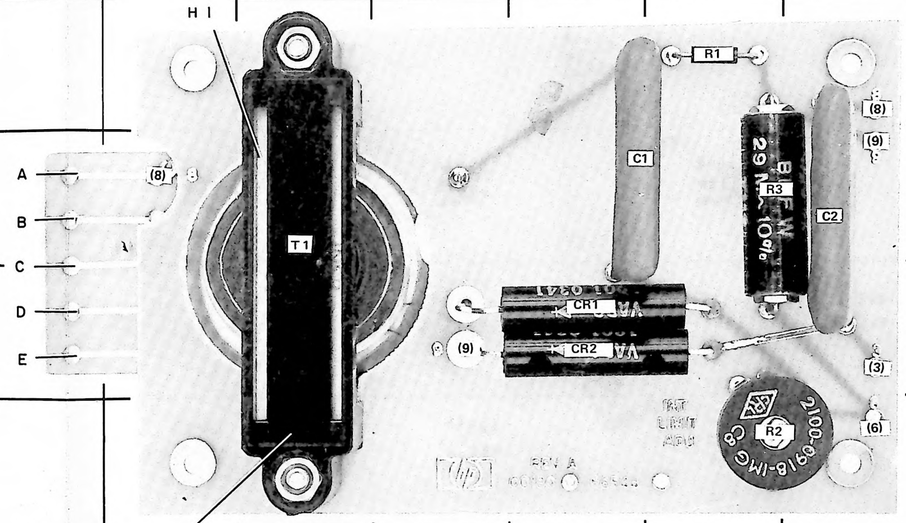
Multiplier

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1														1
2														2
3														3
4														4
5														5
6														6



A4

REF DESIG	GRID LOC
C1	C-3
C2	D-5
CR1	D-2
CR2	C-2
E1	C-4
E2	C-5
L1	D-3
XQ1	D-2



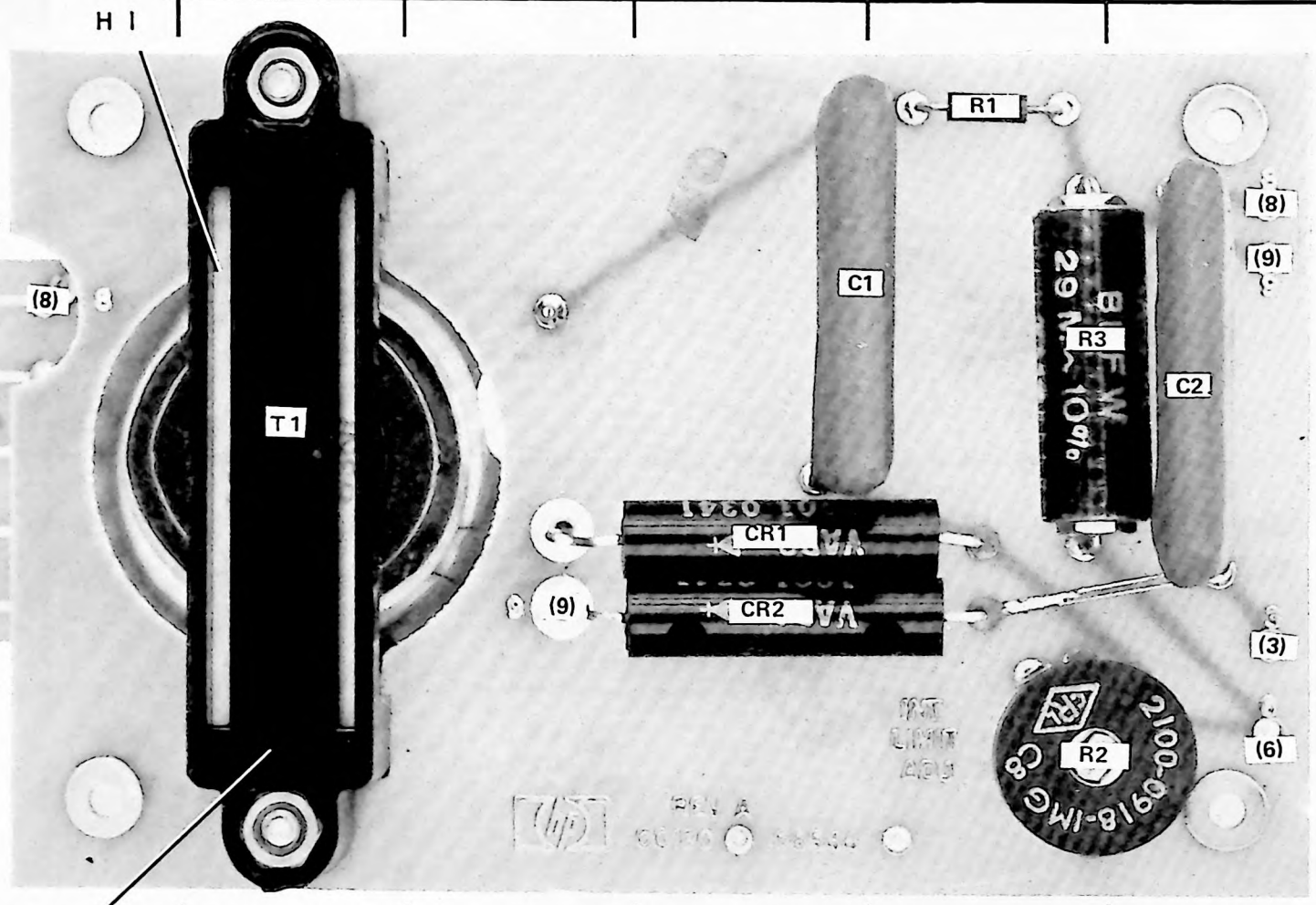
Circuit boards have plated through component holes. This permits soldering from either side of the board.

A5

REF DESIG	GRID LOC
C1	J-3
C2	L-3
CR1	J-4
CR2	J-4
R1	K-2
R2	L-5
R3	K-3
T1	H-3

180C/D-R-9

Figure 8-13. H.V. Oscillator and Rectifier Component Identification



Circuit boards have plated through component holes. This permits soldering from either side of the board.

A 5

REF DESIG	GRID LOC
C1	J-3
C2	L-3
CR1	J-4
CR2	J-4
R1	K-2
R2	L-5
R3	K-3
T1	H-3

180C/D-R-9

Figure 8-13. H.V. Oscillator and Rectifier Component Identification

Table 8-7. High Voltage Power Supply Troubleshooting Tips

Symptom	Suggested Checks
No high voltage.	*Check oscillator power supply fuse. Check oscillator components: transistor, H.V. transformer, diodes, etc.
Voltage too high.	Check H.V. Adjust. Check regulator components and feedback loop. *Increased resistance in regulator feedback loop.
Voltage too low.	Check H.V. Adjust. Check regulator components and feedback loop. *Decreased resistance in regulator feedback loop or CRT loading supply.
NOTE Refer to CRT Intensity Troubleshooting Tips for additional checks.	

* Most common fault.

Table 8-8. CRT Intensity Troubleshooting Tips

Symptom	Suggested Checks
Low intensity.	Check intensity limit adj. Check low voltage supplies. Check high voltage supply. Check gate amplifier. *Check CRT. (See Notes for additional tips.)
High intensity.	Make checks listed for low intensity. *Check H.V. power supply diodes. Check CRT for grid-cathode leakage. Check CRT for open grid circuit. (See Notes for additional tips.)
Flickering intensity.	Check high voltage supply for arcing. Check high voltage leads for arcing. Check CRT for loose connections to pins. Check CRT for possible intermittent internal connection. Check high voltage regulator for intermittent components or connections. Check high voltage supply for intermittent components or connections. Check oscillator connections. (See Notes for additional tips.)

NOTE 1

When troubleshooting the high voltage power supply or CRT, it is helpful to isolate the CRT. Do this by disconnecting CRT base socket and post accelerator high voltage connection. With CRT disconnected, the high voltage circuit is not loaded by the CRT if it is at fault, and the CRT is protected if the high voltage supply is faulty.

NOTE 2

The CRT may be checked to determine if grid-cathode voltage is correct. Use a high-impedance voltmeter (VTVM) which has isolated input terminals to measure grid-cathode voltage. (Voltmeter input terminals must be isolated from ground, i.e.: floating, since grid and cathode are at high voltage in relation to ground.) With INTENSITY control set for maximum intensity (fully cw), grid should be more negative than cathode by about 20V. With control set for minimum intensity (fully ccw) grid should be more negative than cathode by about 75V.

NOTE 3

In checking for cause of excessive high voltage, remember that increased resistance in the feedback regulator loop will result in increasing the H.V. oscillator output. High voltage output from the supply will therefore be increased. Conversely, low output from the high voltage supply will result if the feedback loop resistance is lower than normal. Low voltage can also be the result of increased loading.

*Most common fault

Table 8-9. H.V. Power Supply Voltage Measurement Conditions

1. Plug-ins not installed.

2. LINE power ON.

3. No signal input.

4. Set controls as follows:

 INTENSITY fully ccw

 SCALE OFF

 FOCUS fully ccw

5. All dc voltages referenced to ground.

6. Low voltages measured with HP Model 414A Auto Voltmeter (100 MΩ input impedance).

7. To measure high voltages, use HP Model K05-3440A 1000:1 Divider Probe and HP Model 3440A Digital Voltmeter with HP Model 3441A or 3444A plug-in.

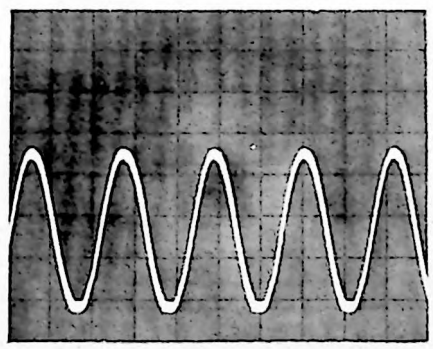


Figure 8-14. H.V. Oscillator Waveform

surement Conditions

. fully ccw

. OFF

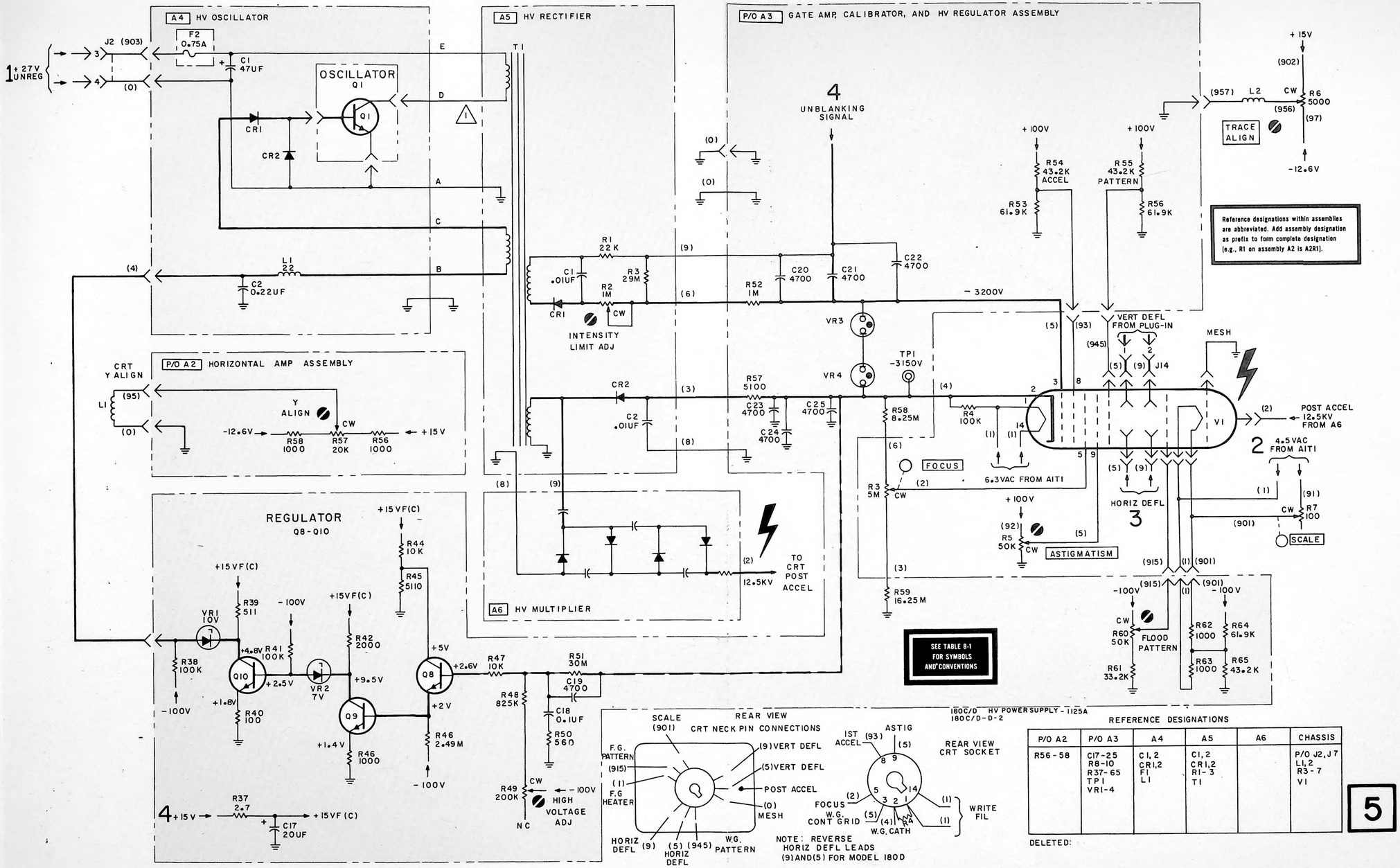
. fully ccw

el 414A Auto Voltmeter

P Model K05-3440A
el 3440A Digital Volt-
A plug-in.

A-12

veform



REFERENCE DESIGNATIONS

P/O A2	P/O A3	A4	A5	A6	CHASSIS
R56-58	C17-25 R8-10 R37-65 TP1 VR1-4	C1,2 CR1,2 F1 L1	C1,2 CR1,2 R1-3 T1		P/O J2,J7 L1,2 R3-7 V1

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5

Figure 8-15.
High Voltage Power Supply Schematic
8-21

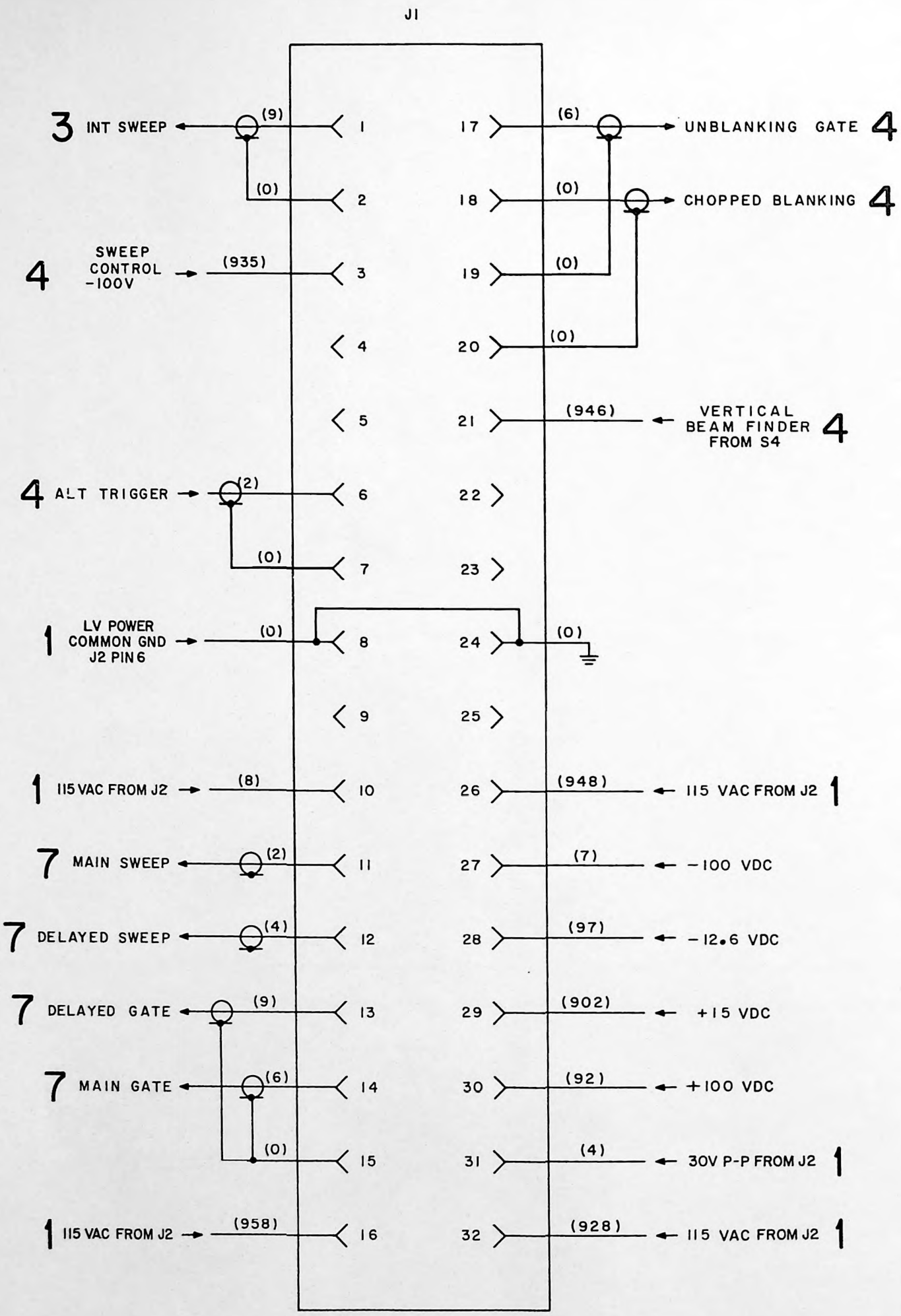
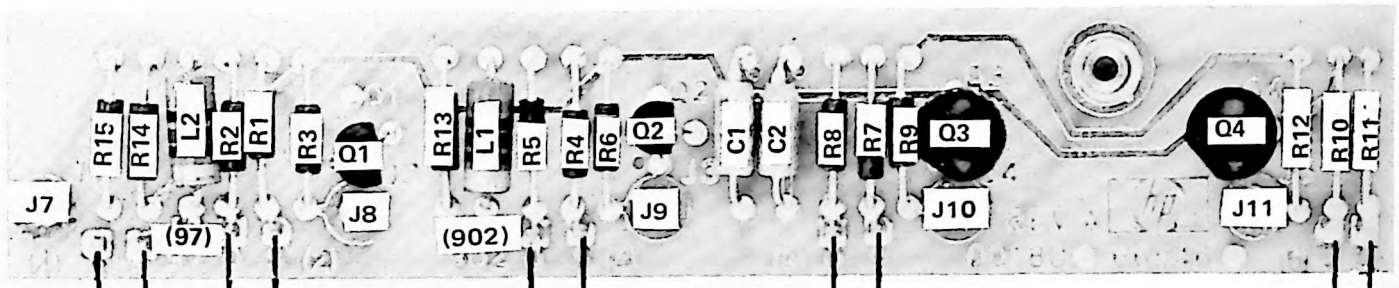


Figure 8-16.
Time Base Plug-in Connections

	A	B	C	D	E	F	
1	Circuit boards have plated through component holes. This permits soldering from either side of the board.						1
2							2
3							3
4							4
5	(4) COAX.	(2) COAX.	(4) COAX.	(9) COAX.		(6) COAX.	5
6							6



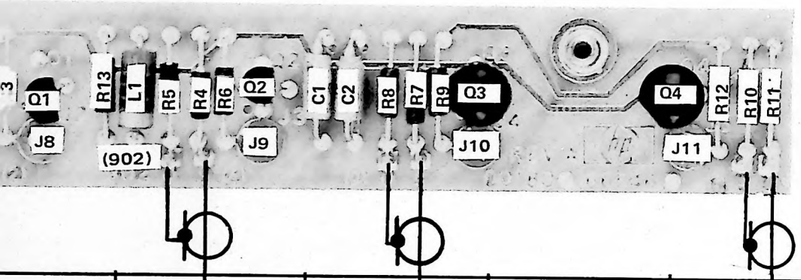
A7

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D-3	Q2	C-3	R7	D-3
C2	D-3	Q3	D-3	R8	D-3
J7	A-4	Q4	F-3	R9	D-3
J8	B-4	R1	B-3	R10	F-4
J9	C-4	R2	B-3	R11	F-4
J10	D-4	R3	B-3	R12	F-3
J11	F-4	R4	C-3	R13	B-3
L1	C-3	R5	C-3	R14	A-3
L2	A-3	R6	C-3	R15	A-3
Q1	B-4				

180C/D - R-7

Figure 8-17. Sweep-Gate Component Identification

B	C	D	E	F	
ave plated through . This permits solder- side of the board.					1
					2
					3
X.	(4) COAX.	(9) COAX.		(6) COAX.	5
					6

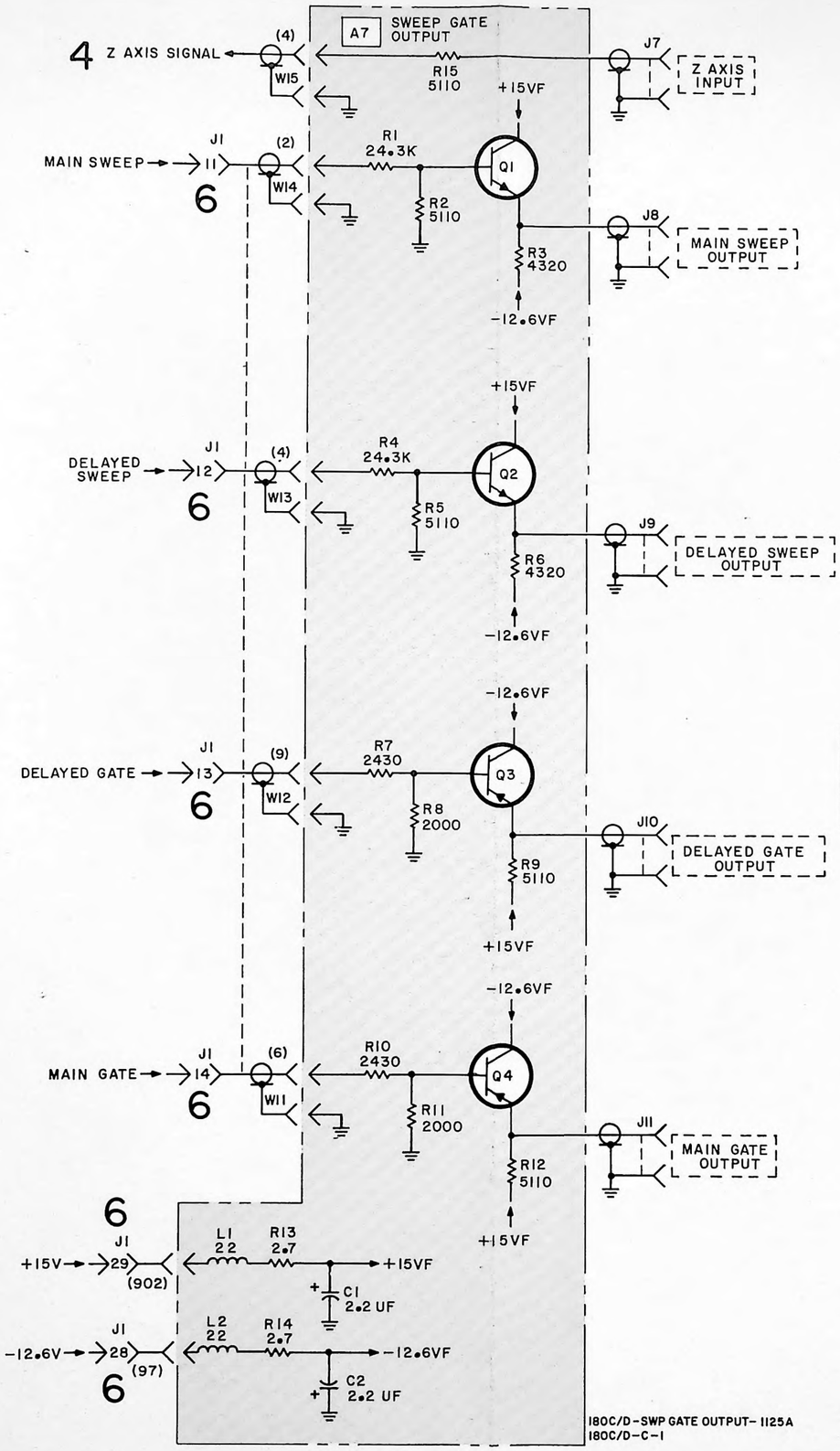


A7

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D-3	Q2	C-3	R7	D-3
C2	D-3	Q3	D-3	R8	D-3
J7	A-4	Q4	F-3	R9	D-3
J8	B-4	R1	B-3	R10	F-4
J9	C-4	R2	B-3	R11	F-4
J10	D-4	R3	B-3	R12	F-3
J11	F-4	R4	C-3	R13	B-3
L1	C-3	R5	C-3	R14	A-3
L2	A-3	R6	C-3	R15	A-3
Q1	B-4				

180C/D – R –7

Figure 8-17. Sweep-Gate Component Identification



Reference designations within assemblies are abbreviated. Add assembly designation as prefix to form complete designation (e.g., R1 on assembly A2 is A2R1).

SEE TABLE 8-1 FOR SYMBOLS AND CONVENTIONS

REFERENCE DESIGNATIONS

A8	CHASSIS
C1,2 L1,2 Q1-4 R1-15	P/O J1,7-11 W11-15

DELETED:

7

Figure 8-18.
Sweep-Gate Output Schematic

F
T
8

CATHODE-RAY TUBE WARRANTY

The cathode-ray tube (CRT) supplied in your Hewlett-Packard Oscilloscope and replacement CRT's purchased from hp are warranted by the Hewlett-Packard Company against electrical failure for a period of one year from the date of sale. Broken tubes and tubes with phosphor or mesh burns are not included under this warranty. If the CRT is broken when received, a claim should be made with the responsible carrier.

Your nearest Hewlett-Packard Sales/Service Office (listed at rear of instrument manual) maintains a stock of replacement tubes and will assist in processing the warranty claim.

We would like to evaluate every defective CRT. This engineering evaluation helps us to provide a better product for you. Please fill out the CRT Failure Report on the reverse side of this sheet and return it with the defective CRT to:

Hewlett-Packard Company
1900 Garden of the Gods Road
Colorado Springs, Colorado 80907

Attention: CRT QA

To avoid damage to the tube while in shipment, please follow the shipping instructions below; warranty credit is not allowed on broken tubes.

SHIPPING INSTRUCTIONS

It is preferable that the defective CRT be returned in the replacement CRT carton. If the carton or packaging material is not available, pack the CRT according to the instructions below:

1. Carefully wrap the tube in 1/4 inch thick cotton batting or other soft padding material.

2. Wrap the above in heavy kraft paper.

3. Pack wrapped tube in a rigid container which is at least 4 inches larger than the tube in each dimension.

4. Surround the tube with at least 4 inches of packed excelsior or similar shock absorbing material; be sure the packing is tight all around the tube.

Thank you,

CRT Department

CATHODE-RAY TUBE FAILURE REPORT

DATE _____

FROM:

NAME _____

COMPANY _____

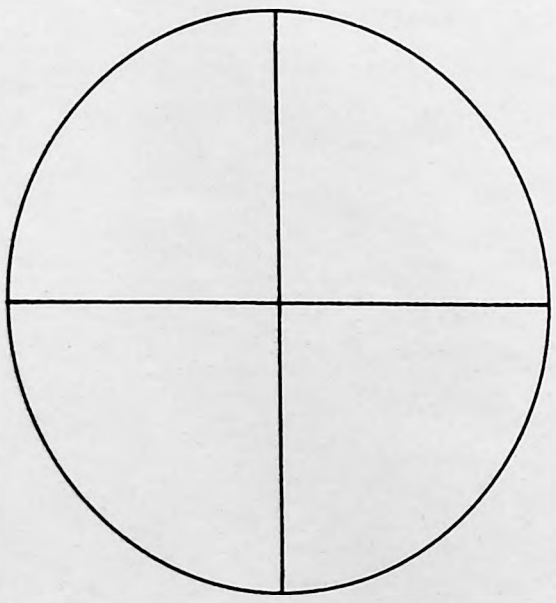
ADDRESS _____

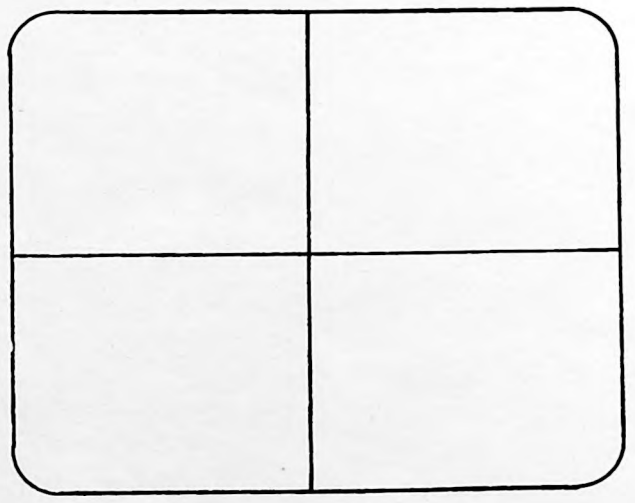
1. hp INSTRUMENT MODEL NO. _____

2. hp INSTRUMENT SERIAL NO. _____

3. CRT SERIAL NO. _____

4. Please describe the failure and, if possible, show the trouble on the appropriate CRT face below.





5. Is the CRT within warranty? Yes_____ No_____

6. hp Sales/Service Office _____ Repair Order No. _____

CUT ALONG DOTTED LINE

02537-4

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Tel: (602) 252-5061
TWX: 910-951-1330

5737 East Broadway
Tucson 85716
Tel: (602) 298-2313
TWX: 910-952-1162

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1430 East Orangethorpe Ave.
Fullerton 92631
Tel: (714) 870-1000

3939 Lankershim Boulevard
North Hollywood 91604
Tel: (213) 877-1282
TWX: 910-499-2170

1101 Embarcadero Road
Palo Alto 94303
Tel: (415) 327-6500
TWX: 910-373-1280

2220 Watt Ave.
Sacramento 95825
Tel: (916) 482-1463
TWX: 910-367-2092

9606 Aero Drive
San Diego 92123
Tel: (714) 279-3200
TWX: 910-335-2000

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7965 East Prentice
Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

CONNECTICUT
508 Tolland Street
East Hartford 06108
Tel: (203) 289-9394
TWX: 710-425-3416

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Norwalk 06851
Tel: (203) 853-1251
TWX: 710-468-3750

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Ft. Lauderdale 33307
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TWX: 510-955-4099

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TWX: 810-850-0113

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Atlanta 30328
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TWX: 810-766-4890

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Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

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TWX: 810-341-3263

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Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

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Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-9157

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2 Choke Cherry Road
Rockville 20850
Tel: (301) 948-6370
TWX: 710-828-9684

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Tel: (617) 861-8960
TWX: 710-326-6904

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21840 West Nine Mile Road
Southfield 48075
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TWX: 810-224-4882

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St. Paul 55114
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TWX: 910-563-3734

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TWX: 910-760-1670

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TWX: 710-441-8270

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TWX: 510-252-0890

82 Washington Street
Poughkeepsie 12601
Tel: (914) 454-7330
TWX: 510-248-0012

39 Saginaw Drive
Rochester 14623
Tel: (716) 473-9500
TWX: 510-253-5981

5858 East Molloy Road
Syracuse 13211
Tel: (315) 454-2486
TWX: 710-541-0482

1 Crossways Park West
Woodbury 11797
Tel: (516) 921-0300
TWX: 510-223-0811

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1923 North Main Street
High Point 27262
Tel: (919) 885-8101
TWX: 510-926-1516

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Cleveland 44145
Tel: (216) 835-0300
TWX: 810-427-9129

3460 South Dixie Drive
Dayton 45439
Tel: (513) 298-0351
TWX: 810-459-1925

1120 Morse Road
Columbus 43229
Tel: (614) 846-1300

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2919 United Founders Boulevard
Oklahoma City 73112
Tel: (405) 848-2801
TWX: 910-830-6862

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4475 S.W. Scholls Ferry Road
Portland 97225
Tel: (503) 292-9171
TWX: 910-464-6103

PENNSYLVANIA
2500 Moss Side Boulevard
Monroeville 15146
Tel: (412) 271-0724
TWX: 710-797-3650

1021 8th Avenue
King of Prussia Industrial Park
King of Prussia 19406
Tel: (215) 265-7000
TWX: 510-660-2670

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